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Purses and Purse Fastenings.—F. Weintraud and R. J. S. Joyce, 3021. J. Muirhead, 3128.

Rags and Waste.—A. Daniel and A. Lessieux, 3081.

Railways, Permanent Way, Rail Joints, Chairs and Sleepers, Portable Railways, Atmospheric Railways, Switches, points, Crossings, and Turntables.—E. Burstow, 2910. A. C. Pilliner, J. C. Hill, and W. Williams, 2914. R. E. Middleton, 2951. J. W. Hartley, 2960. A. Barclay, 2969. G. W. Cottingham, 3003. S. Fox, 3026. E. Feldtmann (com.), 3033. H. R. B. Windels, 3037. M. F. FitzGerald, 3149. J. Page, 3198.

Railways, Carriages, Coupling, Uncoupling, and Altering Position of Carriages and Engines.—J. Brown, 2953. A. Aston, 3034. T. Lishman, 3190. H. Wickens, 3207. C. J. A. Dick, 3224. J. Richardson, 3251.

Reaping, Mowing, Making Hay, Gathering in Produce.—J. L. Hancock, 2944. J. A. Clarke, 3164.

Refrigerating, Cooling Liquids, Making Ice.—H. M. Barnard (com.), 2972. E. G. Brewer (com.), 3240.

Registering, &c.—P. J. Pittar and C. A. Terrey, 2933. A. Steer and J. Hands, 3146. C. Beard, 3181. T. H. Duckworth and S. Wright, 3210. J. J. Barrowski, 3236. T. W. Kellett, 3280.

Retorts and Crucibles.—J. Calderwood and W. M'Cutchon, 3051.

Roadmaking, &c.—H. Windels, 3037. J. G. Wilson (com.), 3232. A. W. Lake (com.), 3276.

Ropes, Cords, &c.—R. W. Powell, 3061. F. Kingston, 3186.

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Sea-sickness (Preventing).—C. Busbridge, 3052.

Sewing and Embroidering.—S. Mort and G. Browning, 2946. W. Searle, 2955. J. Barron, 3034. H. J. Haddan (com.), 3053. M. H. Pearson, 3090. C. G. Hill, 3204. J. Keats, 3272.

Shears, Scissors, &c.—T. H. Heard, 2920. F. A. Casile and L. Boutet, 2987.

Ship and Boatbuilding.—H. A. Clark, 2976. W. Morgan-Brown (com.), 3016. J. W. D. M'Donald, 3019 C. Busbridge, 3052. G. L. de M. Ableiges, 3116. W. Flux, 3117.

Ships (Raising Sunken or Wrecked.—S. Garan, 3098. J. R. and L. Kirkpatrick and J. Bradley, 3137. W. Howe, 3211.

Shot, Shell, Bullets, &c.—A. C. MacLeod, 3129.

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Sifting, Sorting, and Separating.—W. Spedding, 2921. J. Stenson, 3192.

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Sizing and Preparing Yarns for Weaving.—W. Birtwistle, 3260.

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Spades, &c.—H. Fisher, T. Twigger, and E. Ross, 3277.

Sowing Seeds and Distributing Manure.—J. Thomas, 2977. L. A. Aspinwall, 3025.

Spindles; Spindles and Flyers, &c.—J. C. Stanley, 3006. J. Birkenhead, 3002. J. S. Smith and J. S. Sutcliffe, 3101. L. Varicas (com.), 3113. F. Wirth (com.), 3179.

Spinning and Preparing for Spinning.—E. and S. Tweedale, 2916. J. Clapham, 2925. J. Clapham, 2981. J. Birkenhead, 3002 E. and S. Tweedale, 3004. J. C. Stanley, 3006. J. C. Stanley, 3007. W. Terry and J. Scott, 3165. F. Wirth (com.), 3179. E. A. Leigh, 3195. R. Scott and J. Hanson, 3213. R. Curtis and W. H. Rhodes, 3233. H. Martiny, 3265.

Springs.—A. J. Worrall, 3156. C. J. A. Dick, 3224.

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Stamps and Stamping, Seals, &c.—G. R. Cooke, 3205.

Stays, Corsets, Bodices.—W. R. Lake (com.), 3124. Charlotte A. Carlson, 3258.

Steam and other Boilers, Cleaning and Preventing Incrustation of Boilers, Water Feeding Apparatus for Boilers.—J. Calderwood and W. M'Cutchon, 3051. W. E. and A. H. Death, 3127. H. J. Haddan (com.), 3161. R. Gill, 3214.

Steam Engines (Stationary, Locomotive, and Marine.)—R. Droja, 2909. J. P. Piper, 2917. R. E. Middleton, 2951. H. H. Lake (com.), 2965. M. Watron, 3108. J. A. Cunliffe (com.), 3150. G. Donkin and B. G. Nichol, 3172. W. Paulson, 3299. J. E. A. Gwynee, 3231.

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Stone and Slate, Artificial Stone and Marble Grindstones and Millstones.—W. Palmer, 3136.

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Tents, &c.—S. J. Blick, 3118.

Thermometers, Barometers, Pyrometers.—A. M. Clark (com.), 2993.

Thrashing Machines.—E. W. Pamplin, S. Long, and G. Shanks, 3152.

Tobacco and Snuff, Cigars, Cigar-holders, Pipe and Cigar-lighters, Smoking-pipes, Tobacco-pouches.—E. J. Swayne, 3144. H. M. Lee, 3273.

Torpedoes.—C. Kesseler (com.), 3110. J. G. Surmon, 3173.

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Turning, Lathes for Turning.—W. J. Tarrant, 2964.

Umbrellas, Parasols, &c.—W. Hoyland, 3066 M. Wilson, 3169. R. Church, 3219.

Upholstery, &c.—W. R. Lake (com.), 2995. J. Shipley, 3055.

Valves, Taps, Stop Cocks, Plugs; Regulating the Flow and Pressure of Fluids.—C. T. Hill, 2723. H. H. Lake (com.), 2965. W. E. Gedge (com.), 3129. J. L. Cunliffe (com.), 3150. T. Kinch, 3168. T. N. Kirkham and S. Chandler, 3202. R. Gill, 3214.

Velocipedes, Bicycles.—L. W. Boynton, 3107. M. Doubleday and T. Humber, 3126. J. Turner, S. Martin, and J. Adams, 3131. A. J. Worrall, 3156. W. Harrington, 3278.

Ventilation; Supplying and Purifying Air for Buildings, Mines, Ships, Carriages, &c.—N. Hunt, 2945. J. Norris, 3027.

Warping and Beaming Yarns and Threads.—J. J. and G. Ashworth, 2980.

Washing, Cleansing, and Wringing Fabrics, Yarns, and Materials.—G. Holloway, 3042. J. Lancaster, 3138.

Waterclosets, &c.—M. J. Cooke, 2988. J. Dodd, 3114.

Waterwheels and Engines, &c.—H. Simon (com.), 3078. C. Barlow (com.), 3253. B. Walker and J. and A. Pflaum, 3268.

Wearing Apparel for Gentlemen, Military Outfits, &c.—H. R. Newton, 2882. L. W. Carmichael, 2983.

Weaving, Braiding, Plaiting, Preparing for Weaving.—J. and J. E. Newton, 2938. J. J. and G. Ashworth, 2980. W. Ashburn, 2991. J. and D. Clayton, 3044. J. S. Smith and J. S. Sutcliffe' 3101. J. Holding, 3178. F. Wirth (com.), 3180. W. Birtwistle, 3260.

Weighing Machines, Scales, Indicating Weight.—T. P. Hewitt, 3071. J. V. Hope, 3194.

Window Blinds, &c.—N. Hunt, 2945.

Windows and Sashes.—H. E. N. Mason and J. Price, 3040. C. H. Parkin, 3154. B. Turner, 3239.

Wire-Working, Wire Ropes, Telegraph Cables.—J. H. Nettlefold, 2962.

Woods and Veneers, &c.—D. R. Gardner, 3261.

*** *The above List is prepared from the Patent Records by Mr. T. Morgan, Secretary of the Inventors' Patentright Association, Limited.*

NAIADS' SONG.

Rura mihi, et rigui placeant in vallibus amnes,
Fluminea amem silvasque, inglorius! VIRGIL.

Our home is where the fountains play,
And glitter 'neath the sunlight's ray;
Where glide fair streams in fancy free,
By valleys decked with daisied lea;
'Mid all the charms that nature bears,
Where live the sweets her altar shares.

We make the woods a welkin ring—
In tuneful choir our nations sing;
While shepherds, in the morning tide
Bring garlands rich to deck their bride;
And in the sunshine of our smiles
They crown us queens of maiden iles.

We roam through meads where rivers wend,
Where willows wave, and poplars bend;
'Mid Sylvan scenes, and silent shade,
By wood, and fern, and sunny glade:
Till round our isle the moonlight's shed,
Which woos us to our mossy bed.

Henry George Hellon.

The American Oyster.—It is a well-known fact that the edible oyster (*Ostrea edulis*) attains its full growth and proper flavour only in the waters of the American coast; and that its representatives in Great Britain, owing perhaps to some trouble in its "environments," has dwindled down to a minute coppery-flavoured bivalve, which affords to the evolutionist a melancholy example of "reversion," and to the American gastronome an object of aversion. It is no wonder, then, that when one of our American oysters is seen for the first time by an inhabitant of the British Isles, it should call forth expressions of great surprise. An English gentleman who has been indulging in some of our exported "Blue Points," writes to the "Notes and Queries" column of a recent number of *Land and Water*, asking for information in regard to these "delicious mollusks."—*Scientific American.*

Reviews.

MAKING WROUGHT IRON AND STEEL.

"On the Direct Process of Making Wrought Iron and Steel." By Chas. M. Du Puy, C.E. Reprinted from the "Journal of the Franklin Institute," for December, 1877. Philadelphia: Wm. P. Kildare, 734 and 736, Sansom-street. 1877.

This pamphlet has reference to a subject of such great practical importance that we are induced to present our readers with a more extended review than we usually bestow upon works of such brevity.

The author, after some preliminary remarks as to the distinction between the "direct" and "indirect" processes of producing iron, touches upon the history of the subject, and mentions that in 1791, Samuel Lucas patented a process for reducing ores with carbon in air-tight pots; in 1794, Mushet forged iron which he had carefully reduced, away from the atmosphere, and brought to the pasty state in a crucible; and that others have passed over the same ground. He considers that it is likely that the reduction of iron in crude clay pots has been known to the people of Asia for a thousand years or perhaps earlier.

As to the present state of the question, Mr. Du Puy considers that the different processes may be thus classified:—

1. Close retorts or crucibles of various shapes and sizes, heated from the outside, being substantially the "Air-tight Pots," patented by Lucas.

2. Tables of refractory material, heated from above and below, on which the air and carbon are placed and stirred, and finally transferred to a balling hearth.

3. Revolving cylinders, containing ore and carbon, and heated from the outside, or within.

In the first two classes, deoxidation is supposed to be completely accomplished in the first operation, and the balling is done in a second furnace, but in the last class Dr. Siemens' invention, the rotary cylinder, the gas from the producers is poured into the inside of the cylinder, until not only complete deoxidization is effected, but until the metal in the pasty state may be divided into balls, for removal to the hammer.

By a long series of experiments, the author of the pamphlet became convinced of the superiority of the "close pot," and to secure the advantages of the "close pot" it became evident that some substance should compose it that should withstand the high welding heat and be homogeneous with the metal, and, finally, when its work was done, and the ore changed to metal, would weld up with it.

In this dilemma, after testing various materials, the idea was conceived of using thin sheet iron as an encasement, or canister, it being found by experiment that it would resist a high heat for several hours. These sheet iron vessels, filled with ore and carbon, during several years, were tried, of all sizes and shapes, and in almost every conceivable furnace. It was found that superior iron could be produced in these canisters in seven or eight hours, but the yield was unsatisfactory, when over five inches in thickness, owing to a failure of thorough reduction, and of that diameter, the cost for sheet iron was too large in proportion to the iron obtained.

Still believing that the process could be made practical, and produced in from 4 to 6 hours at a low cost, he proceeded with his experiments, which culminated in a process embracing four ways of working.

1. If it is desired to make steel, the filled canisters are charged on end into the furnace on a layer of coke, a few inches in thickness, so as to allow the heat to penetrate from the bottom, as well as sides and top. They are usually 7 to 8 inches apart to secure a radiation of heat between them.

In the course of from five to seven hours, according to the strength of the heat, the ore will be reduced from its oxide and settle down in almost a solid metallic mass, so firm as to be separated and broken with great difficulty, even in its highly heated state in the furnace. In this solidified condition it is removed and hammered, or thrown into the squeezer and rolled to muck-bar, at this one first heat. It is then cut up, reheated and piled, with the usual loss of 8 to 10 per cent of ordinary piled iron. This stock is then fitted for the steel pot, producing all grades of steel, up to the highest, without mixing with other stock, but by simply varying the carbon.

2. The caked metal may, if preferred, be taken in its heated state to the Siemens open hearth, or other highly heated furnace, and there quickly melted with or without the usual carbonizing bath of pig and spiegel. In the condition of white heat, in which it is charged into this last furnace, it is admirably adapted for a rapid conversion to steel in large quantities, and and at great economy of fuel.

3. The metal, when reduced, he says,—I melted down in the same furnace and carbonized with pig iron. In operating the entire process in one furnace, the product may be brought out as either iron or steel at pleasure, by varying the carbon introduced at or before the time of melting.

4. Another method I have adopted in working this metal, is to take the cakes as reduced, at their white heat, and sink them in the forge fire. The quality of the metal is thereby highly improved in toughness, as illustrated by samples of sheet iron here exhibited. By throwing the heated metal into the forge fire in this way they sink, and are taken to the hammer in a half hour, with half the expenditure, both of fuel and labour, that is ordinarily required in sinking scrap in a forge fire. Still, even in the forge fire, red shortness is not cured. This is accounted for by the rapidity of passing the metal before the tuyere in the melted state, which does not give time for the absorption of carbon, and, although improved in every other respect, it comes from the forge fire nearly as red short as when it was thrown into it. It requires the longer contact with carbon than is there so briefly allowed.

Iron made in this manner in cakes of metal is, it appears, generally red short in its nature, and Mr. Du Puy gives very detailed information as to how he deals with this quality, remarking that it will be observed that a triple chemical operation begins to take place at once, from the moment the canisters are charged into the furnace.

First. The oxygen of the ore combines with the carbon, passing off as carbonic oxide. Second. The silica and alumina combine with alkalies introduced, and form the glazing material which cover the particles of newly-made metal, effectually sealing these particles from reoxidation from the furnace gases. Third. The phosphorus melts into this glass, and passes off with it as a slag, not contaminating the iron. The average of 14 analyses of the ore from the Republic Mine of the Lake Superior district gives metallic iron 68·48, phosphorus 0·053, silica, 2·07. The analysis of reheated iron from the same ore made by my process, as given by Dr. Otto Wurth, of Pittsburg, is as follows:—Carbon 0·042, silicon 0·021, sulphur. 0 032, phosphorus, 0·016, slag, 0·185, iron 99·700. Other detailed information on this subject is afforded in this pamphlet, but we have no space for further quotation. We can only state that this little work is worthy of the perusal of all who are interested in iron manufacture; also that the invention appears to be worthy of trial. We may mention that Mr. P. G. Justice, of 14, Southampton-buildings, Chancery-lane, appears to be the party in England who has the invention in hand.

EFFECTS OF HYDROPATHY.

"Testimonies to the Efficiency of Hydropathy in the Cure of Disease," comprising:—I.—Prospectus of the Establishments at Paddington Green, London, and New Barnet, Herts. II.—Medical Opinions on the Efficacy of Hydropathy and the Turkish Bath, with Testimonials. By Richard Metcalfe, F.S.S. III.—A Plea for Hydropathic Dispensaries. By Richard Metcalfe, F.S.S. IV.—A Guide to Barnet and its Vicinity. By Edward Henry Nolan, Ph.D., LL.D. V.—Confessions of a Water Patient, with a Preface. B Lord Lytton (Sir E. Bulwer Lytton London: W. Tweedie & Co., Limited, 337, Strand.

This little work is the production of a practitioner of hydropathy, and therefore its statements must be accepted *cum grano salis*; however we consider very cogent the advice by the late Lord Lytton, to invalids thinking of placing themselves under hydropathic treatment, to the effect that on the subject of hydropathy, you may pause if you please—inquire if you please—inquire if you will—but that it is useless to consult your doctor, for you cannot, as a rule, expect a doctor of drugs, however honest or honourable, to say other than that doctors of water are but quacks. We therefore advise all whom it may concern to carefully peruse this work, the title page of which gives a sufficient general indication of its contents for our pages.

☞ Postponements. — Several Reviews and other articles, especially "Hymettus to J. G. R." (poetry), are unavoidably postponed.

An Electric Light for the Human Body.—An extraordinary application of the electric light is proposed by Professor Edison. His plan is to make a diminutive light apparatus, and enclose it in a glass globe of such size as to be easily swallowed. He will connect it with a suitable battery, and he expects to be able to witness the process of digestion, and to see with more or less distinctness the operations of the internal organs.—*Scientific American*.

RAISING OF SUBMERGED SHIPS.

The immense treasure lying buried in the sea all around our coasts in ships and cargoes, unclaimed and given up as irrecoverable, is a subject which has often engaged the serious attention of all concerned in our maritime power and wealth. Scarcely a month passes without adding to the melancholy list of disaster—frightful loss of life, and vast sums of valuable property. The former is beyond human power to remedy: the latter, a mine of almost fabulous value, should not, in this advanced period of inventive intelligence and engineering skill, be abandoned as hopelessly lost. Doubtless there exist, from the very nature of the case, formidable difficulties to be surmounted; intricate and varying obstacles to be overcome; but human skill has not yet reached its limit, and unless the laws of nature declare it to be impossible, there is hope of ultimate success crowning an intelligent and persevering effort to recover, at least, the more valuable and easily-reached argosies of buried wealth.

Various plans have been invented, scores of ingenious theories advanced, large sums expended on patents perfected, or abandoned before completion. A few attempts have been made to raise the submerged treasure, but the undisputed fact remains, that, compared with the general desire, nothing — practically *nothing*—has been done. Once admit the possibility of raising a sunken vessel—say, for example, from ten to twenty fathoms—reason and science ask—What means are required for success? They are few in number and easy of comprehension. The first is, sufficient raising power in any form of pontoons or vessels. No practical difficulty can arise here; a very simple calculation determines the question, and is perfectly known to all marine engineers. The second element of success—How to get a thorough and safe hold of the ship's hull? unless well understood and brought into action, leads to costly attempts and miserable failures.

And just at this point, as if some weird conjurer started a myriad of "spirits from the vasty deep." there confronts us a host of prejudices, rallying from all points of the compass, compact as a phalanx at Thermopylæ, more difficult to overcome than the *vis inertia* of the buried fleet around our shores, whose battle-cry is, "Is there anything new under the sun; can any new idea spring from the brain of a common person—a *layman?*" Pausing, we say there may be a possibility of such a thing, while memory reverts to Arkwright, Watt, &c., &c., reasoning wisely, that "what has been may be," and that anything is possible to human skill which physical laws do not plainly forbid.

At the present time a fresh plan is embodied in a Patent, the Specification and Drawings of which are in process of publication. Instead of a few uncertain and generally unsafe holds taken of the sunken ship, a coil is formed around and under the bilge of hempen and steel-wire rope, in several layers or rounds, secured in an ingenious manner, and by the least possible aid from divers, merely to fasten the commencement and the end of the cables composing the coil. Under the coil, and previous to its being laid down, steel-wire lifting-ropes are laid, one end of each being secured on a lighter above the ship, the other drawn outwards and fastened on a lighter at such a distance as will secure free working of tugs or boats all around the position of the ship. When the coil is completed, the lifting-ropes, now attached to the proper floating power, act on it equally all round, the effect being an immensely strong coil or truss all around, and partly under the strongest portion of the frame of the submerged vessel, yielding as much as will prevent the snapping of one or more of the lifting-ropes by undue strain (as in the ordinary process) until all come into full bearing power, and yet, on its whole round, not moving appreciably from its proper position.

Should this plan prove sound, it is e vide a great advantage will be gained on all former methods, as all the work is proposed to be done from the surface, except the aid of a diver for probably an hour or so, as before mentioned. Nor need the process be tedious. In favourable working weather, with the raising power, ropes, &c., at hand, the operation of raising would it is thought scarcely occupy a week.

THE VIRTUES OF MUSTARD.

The following *on dit* has been going the round of the Paris papers. During the recent visit of the Shah of Persia he was invited to a grand banquet by a cabinet minister. His Imperial Highness is understood to be a good diner, therefore the *menu* was of the most lavish description. The distinguished Persian amazed the company with the rapidity with which the different dishes disappeared beneath his Imperial jacket: oyster *pates*, jellies, trouffles, olives, mushrooms fried in oil, pickled lampreys, and Persian conserves vanished in rapid succession, alternated with frequent libations of sherbet, champagne, and rum punch. At last he began to feel serious misgivings that something was decidedly wrong, and it soon became manifest that there was a commotion in the region of the Imperial epigastrum. It was three o'clock in the morning, and no physician could be found. The whole palace was in a dreadful state of alarm, for unless something was done, Persia might be mourning her Shah, and all the prime ministers be doomed to death. An old lady who was present, suggested an emetic and a mustard plaster, which being applied to the part most affected, soon brought the Imperial sufferer relief. Delighted and amazed at this miraculous cure, he inquired who was the inventor of this marvellous compound, and was informed that it was made by Messrs. Keen & Co., the celebrated mustard manufacturers of London, who had made it for the past hundred and thirty-six years, and who have been royally endorsed for a century. It is said that the Shah immediately ordered one hundred cases, and insisted upon every one of his ministers putting on a plaster at once to see how good it felt. It is also said that this article is to be in future a standing medicine in the Empire. The excitement for Keen's mustard has reached the restaurants, and is to be seen everywhere, while blazing placards proclaim its virtues. It is an admirable addition to roast beef, is invaluable for any kind of salad, and preserves you against the inclemency of the weather. Lucky Keen to have a Shah! Lucky Shah to have a Keen! Vive le Shah, Vive Keen!

Foreign Science.—There being little of novelty to record this mouth, and our space being much pressed upon, we have dispensed with this article for the present month.

Plastilina, a New Modelling Clay.—This substance, which has recently been introduced in Germany, is claimed to have the advantage that it does not dry up, and removes the necessity of keeping the model under damp clothes to prevent its drying and cracking. To make it, a small amount of oleic acid, easily obtained from stearine candle factories and in some soap works, is mixed with zinc white and heated, so as to saponify the zinc with the acid, forming then a mass similar to wax when left to cool; this is then mixed with the rest of the fatty acids, the sulphur is best added in the form of flowers of sulphur, or otherwise very finely pulverised solid sulphur sticks; the clay is dried and also finely pulverised and all mixed as thoroughly as possible while warm. Satisfactory results may be obtained by taking eight parts of glue separated with one part of zinc oxide, four parts of oleic oil, two of wax, six of sulphur, and three of clay; as this gives a mass very much like the Plastilina, and at a comparatively nominal cost,

A MANUFACTURED COMET.

In that ably-conducted serial, *Harper's Journal*, Simon Newcomb supplies the following interesting communication:—

The work of making astronomical observations is about the most laborious and trying in which an intellectual man has ever to engage. Any difference of temperature between the air which surrounds him and that outside would be fatal to the accuracy of telescopic vision; so that no matter how cold the night may be, not only must no artificial heat be allowed him, but he must take special pains to have his observing-room as cold as the outer air. He must sit perfectly still, his attention concentrated upon the object which he is scrutinizing. Gloves can hardly be allowed him, because they would interfere with the delicacy necessary to handling his instrument. And whether it be warm or cold, he must pursue his avocation during the hours when the rest of the world are enjoying themselves in sleep. If he wants to discover a comet, he will find the search as trying to his patience as the observations are detrimental to his physical comfort. He may scan the heavens with unwearying assiduity on every clear night during an entire year, and yet not be rewarded with a single discovery.

All this the Chevalier d'Angos learned from sad experience. This gentleman was one of the famous Knights of Malta, during the latter half of the last century, and being imbued with an astronomical taste, had built himself a small observatory, or perhaps got it built by the brotherhood. He was known in the astronomical world as the computer of cometary orbits at a time when such computations were much more difficult than they are at present. But up to the time when our story commences, although he had made a few observations with his telescope, he was not known to have made any discovery whatever. It was in the year 1784 that a happy thought struck the ambitious knight, the development and results of which form the principal subject of our story. In May of that year, Messier, of Paris, celebrated as the discoverer of comets, received a letter from d'Angos stating that he had discovered a small comet without any tail on the night of April 11th. At first he supposed it to be a nebula. Still, in order to make sure of it in case it should prove to be a comet, he had carefully fixed its position among the stars.

Two or three cloudy nights followed, when he found it again, and saw that it had moved several degrees. He now knew it was a comet and therefore communicated his observations to the Paris astronomer. In the following month the observatory at Malta was destroyed by fire, with, as was supposed, all its papers. It was therefore feared that this was the last of the comet. In those times it took a month for a letter to reach Paris from Malta, so that when Messier heard of the discovery it was too late. But a couple of years afterward there appeared in a mathematical journal published by the celebrated Bernoulli a series of observations on the comet by d'Angos, extending from the 11th of April to the 2nd of May; also a set of elements, supposed to be derived from the observations, showing in what orbit the comet moved around the sun. D'Angos added that the elements represented the observations with almost entire exactness. So far there was nothing at all to excite suspicion: but when mathematicians came to scrutinize these observations more closely, they were not only unable to reconcile them with the orbit given by d'Angos, but, in fact, with any orbit whatever. No heavenly body had ever been known to move in an orbit so erratic as that which the observations would indicate, while the orbit assigned by d'Angos would have placed the comet in a quarter of the heavens entirely different from that in which he professed to have observed it. Evidently there must be some mistake in the numbers given by the Chevalier. But it was impossible to correct them in such a manner that the corrected orbit would represent the observations. The nearest approach that could be made was to suppose the comet so near the earth as almost to move around it like a satellite. A suspicion that the whole thing was a fabrication now began to gain general credence. But beyond the seeming impossibility of representing the observations, no proof of the fabrication could be afforded. When the observatory was burned, all the papers were burned with it, so that it was impossible to refer to the original records. No one else had seen the comet, but then d'Angos himself said it was a very faint one; consequently it might well have escaped notice. Finally, if the observations were entirely fabricated, it would be supposed that the Knight would take good care to have them correspond to the orbit which he had marked out, whereas, as we have said, there was no such correspondence whatever. What made the thing still more inexplicable was, that d'Angos understood perfectly the art of computing cometary orbits as then practised.

Thirty years passed away, and d'Angos was dead and gone before any new light was thrown upon the difficulty. The comet still figured among the discoveries of that yetar, but no one had explained the obseraaieons. Olbers, about 1820, subjected the latter to a new examination, and, like others who had done so, was led to the conclusion that no comet could have moved in the manner in which d'Angos pretended to observe it. The only explanation seemed to be that he had assumed some orbit, calculated how the comet would appear from the earth if it moved in that orbit, and then pretended to have observed it in the calculated positions, but that in making his calculations some mistake had crept in. Olbers asked Encke to take up the subject and see if he could meet with any better success in explaining the matter. Encke satisfied himself, as others had done before him, that it was impossible to represent the observations by any admissible orbit. At length, after many trials, he took the orbit of d'Angos and sought to find in what way it would have to be changed to represent the observations. The clue to the whole forgery was at length reached. Take this orbit, but multiply all the distances of the comet from the sun by ten, which merely involves a mistake of one figure in a certain logarithm, and the observations are all reproduced pretty much as d'Angos gave them. The mystery was then solved. The Chevalier, anxious to figure as the discoverer of a comet, had imagined this orbit; supposing the comet to move in it, he calculated the positions in which it would appeari from the earth; but by one of those accidents which so frequently happen to the dishonest, he had made a mistake of just one figure in the number representing the distance of the comet from the sun, and thus not only completely spoiled the result, but left concealed in his numbers the key which was to lay open his forgery long after he should be dead.

ELECTROTYPES OF THE BRAIN.

Among the novelties to be seen at the Paris Exhibition is a series of specimens of plated human brains sent by Dr. Ore, the ingenious Professor of Physiology at the Bordeaux School of Medicine. Dr. Ore has applied galvano-plasty for purposes of preservation to the brains of men and animals, and has obtained very remarkable results, the external surface presenting the hard brilliant surface of a metal, while the inner substance assumes the consistency of mastic, and is quite unalterable.

Proceedings of Societies.

ASIATIC SOCIETY.

June 17th.—Sir H. C. Rawlinson, President, in the chair.—Mr. R. N. Cust read a paper "On the Present State of Linguistic Research in India, and on the Chief Living Anglo-Indian Scholars," in which he reviewed at great length all that had been done recently, and was still doing, for Oriental literature, mentioning for each district under his survey, beginning from Bombay on the south-west to Bengal and Assam on the extreme east, the grammars, dictionaries, or vocabularies with which he had become acquainted, representing probably, on the whole, not less than one hundred and eighty dialects or languages. His object was to collect information as to the modern dialects and languages rather than as to the Sanskrit, and at the same time to mention the names of every scholar of eminence in India and Europe, and the particular lines of study on which each one had been engaged, with the results thus obtained for the general history of Oriental languages. The Council nominated Messrs. Chennery and Brandreth as Delegates from the Asiatic Society to the Oriental Congress at Florence.

ASTRONOMICAL SOCIETY.

June 14th.—Prof. Cayley, V.P., in the chair.—M. E. G. Deville and Mr. F. Main were elected Fellows. Prof. Adams explained a remarkable property of the coefficients in the analytical expression for the constant term of the moon's horizontal parallax. Capt. Tupper read a paper "On the Measurements of the Photographs of the Transit of Venus taken by the English Government Expeditions." Careful precautions were taken to get rid of any constant source of error arising from distortion of the instruments, and from errors in estimating the positions of the centres of the Sun and Venus, and the photographs were then measured independently by Mr. Burton and Capt. Tupman, but the discordances were found to be so great that it was evident that the measures would be useless for determining the Sun's distance. The Astronomer Royal said that he could not account for the discordance in the measures of the photographs; every precaution had been taken sor eliminating errors of a constant nature, but the difficulties arising partly from irradiation and partly from other causes rendered the measurements comparatively useless. The general result derived from a measurement of the photographs was 8″·2, while the parallax derived from the eye-observations was 8″·83, results which were quite inconsistent with one another. A paper from Prof. Young was read, on his observations of the transit of Mercury made at Princetown. Prof. Young had not been able to see any trace of a ring round the planet or of a spot upon its disc. With the spectroscope he had not been able to detect any change in the solar spectrum at the limb of the planet such as would probably be caused by the absorption of the Sun's light in passing through a planetary atmosphere. On examining the planet with a Mertz polarising eye-piece and a high power, the structure of the photosphere appeared lengthened out radially to the limb, which was just the contrary effect of that which might be expected to arise from a refracting atmosphere. Prof. Young was, however, inclined to think that the phenomenon was wholly subjective. Mr. Christie read a paper "On the Bright Lines or Interspaces in the Solar Spectrum near G, which had been attributed by Prof. H. Draper to the presence of Oxygen in the Sun." Mr. Christie showed a drawing which he had made with a half-prism spectroscope, in which the bright lines appeared as broad bands compared with the dark lines. He had been unable to trace any degradation at the edges of the bright bands such as he thought would probably be seen if they were due to bright lines superposed upon the spectrum. He had also found narrow dark lines towards the centre of more than one of the bands, which he thought was inconsistent with the idea of their being due to pairs or groups of bright lines. Mr. Ranyard pointed out that we are already aware of the existence of a bright line in the chromosphere, namely D_3, which had no equivalent amongst the Fraunhofer lines. The 1474 line, which was the brightest line of the chromosphere, and only corresponded to a faint Fraunhofer line, also appeared to contradict the law of exchanges, as usually stated; there seemed, therefore, to be no theoretical difficulty connected with the existence of bright lines, and it still needed to be shown that the coincidence in the position of the oxygen lines which had been made out by Prof. Draper with small dispersion did not hold. Mr. Schluster said that the lines of the oxygen spectrum were all broad, but he was not inclined to think that Prof. Draper had made out his case.

BRITISH ARCHÆOLOGICAL SOCIETY.

June 12th.—Mr. T. Morgan, Treasurer, in the chair.—It was announced that Lord Hardwicke had been elected President of the Association for the ensuing year, and that the annual Congress at Wisbech had been fixed to commence on August 19th. The discovery of the Roman remains at Lincoln, mentioned in this journal by Canon Venables some short time back, was announced. The works of excavation at the Roman villa at Itchen Abbas has been resumed, and the Rev. Mr. Collier exhibited sketches of the peculiar pottery discovered. Lieut. Morgan described some early buildings in Kashmir, square stone tombs with earthen mounds above them, having analogy with some in Cornwall. Mr. Irvine reported the discovery of the mound and earthworks of a Saxon castle, hitherto unnoticed, at Farewill, Stafford. Mr. Roach Smith described a Roman coffin of lead, which has recently been discovered in the modern cemetery recently opened at Chatham. It is ornamented with a border of diagonal markings and one escallop shell. Mr. R. S. Ferguson announced the discovery of some mediæval stockading at Carlisle, near the site of one of the ancient gates of the city, together with some stone balls. Mr. Compton described the practices still kept up in Shropshire in relation to the preparation of Simnell cakes. Mr. L. Brock exhibited several articles from recent excavatious in the City, including a siegular brown-ware jug of the sixteenth century. Mrs. Clagett produced a curious Spanish cup, and Mr. Burgess described some singular brass *repoussée* plates and other vessels from an old house at the Cross, Worcester, which was said by tradition to contain relics of the Spanish Armada. One of the vessels is dated 1572, and has the arms of Phillip of Spain. The first paper was by Mr. E. M. Thompson, "On an Exultet Roll of the Thirteenth Century in the British Museum." It is adorned with curious drawings on the contrary way to the writing, that they might not be reversed when seen by an audience during the reading of the roll when the latter was unrolled in the course of reading. The second paper was by Mr. G. Hills, who took for his theme the alleged discrepancies of the geography of Ptolemy as applied to the southern portion of England.

ENTOMOLOGICAL SOCIETY.

June 5th.—H. W. Bates, Esq., President, in the chair.—Mr. J. A. Finzi exhibited a remarkable hermaphrodite specimen of *Anthocaris cardamines*. Mr. Rutherford exhibited a series of large cocoons from Mount Camaroons, formed by the larvæ of a species of Bombyx allied to *Anapha panda*, Bdv.

These cocoons varied in diameter from 4 to 7 inches, and each one contained from 130 to 150 smaller cocoons, all of which were tenanted by a larvæ or chrysalis in various stages of development. It would appear that *Anapha panda*, like some other species of Bombycidæ, is social, and that the larvæ unite to form an aggregate cocoon of sufficient strength to withstand the attacks of enemies, and probably extreme changes of temperature. Mr. Rutherford also exhibited a specimen of a Papilio as a case of so-called "hermaphroditism," with asymmetrical marking on the wings, which approached respectively *Papilio cynorta* and *Papilio Boisduvalianus*, thus creating an impression that those two forms were but the sexes of one species. These specimens were from the collection of Mr. F. J. Horniman. Mr. Meldola exhibited photographs of two species of tropical Orthoptera, sent to Mr. Darwin by Dr. Zacharias as an illustration of protective resemblance in the very perfect leaf-like appearance of the fore wings; and some small beetles of the genus Spermophagus and their cocoons, which had been found in a packet of seeds of *Cassia neglecta*, sent from Brazil by Dr. F. Müller to Mr. Darwin. The full-grown larvæ had emerged from the seeds, leaving the latter in a damaged condition, and had spun the small cocoons from which the issued, the insects having reached this country alive. Mr. Meldola also exhibited the proboscis of a sphinx moth, caught by the narrow tube-like nectary of a pale yellow Hedychium, which had likewise been received from Dr. F. Müller, who states that sphinges are frequently found caught in this manner. Sir S. Saunders communicated notes by M. M. Lichtenstein on new ideas as to the life-cycle of Aphidians, giving the results of considerable breeding experiments. The Secretary read a paper from Dr. F. Müller, entitled "Notes on Brazilian Entomology," in which the author gave the results of his observations on the odours emitted by butterflies and moths, as well as facts bearing on various other subjects more or less connected with the theory of evolution. In reference to this paper, the wings of *Antirrhæa Archæa* from Brazil and of *Mycalesis Drusia* from the Nicobars were exhibited in illustration of the author's theory of "scent-fans." The following papers were also communicated: "On some Longicorn Coleoptera from the Hawaiian Islands," by Dr. Sharp; "On the Larvæ of the Tenthredinidæ, with special reference to Protective Resemblance," by Mr. P. Cameron; and "On *Macropsebium Coterelli*, and other New Species of Coleoptera from Lake Nyassa," by Mr. H. W. Bates. The author exhibited the remarkable Longicorn beetle above designated, which possessed some prominent characters of the Prionidæ.

MATHEMATICAL SOCIETY.

June 13th.—Prof. H. J. S. Smith, V.P., in the chair.—Mr. T. R. Terry was admitted into the Society, and Mr. J. D. H. Dickson, M.A., was proposed for election. Dr. Hirst gave an account of a paper, by M. Halphen, 'On the Characteristics of Systems of Conics." Mr. J. J. Walker read a paper "On a Method in the Analysis of Plane Curves." Mr. Tucker (Hon. Sec.) communicated the following papers: "The Calculus of Equivalent Statements, II., by Mr. M'Coll; "On the Flexure of Spaces," by Mr. C. J. Monro; "On the Decomposition of Certain Numbers into Sums of Two Square Integers by Continued Fractions," by Mr. S. Roberts; and "On a New Method of Finding Differential Resolvents of Algebraical Equations," by Mr. R. Rawson. Questions were asked by Professor Cayley, Mr. Merrifield, and Mr. Tucker.

HISTORICAL SOCIETY.

June 13th.—Dr. B. W. Richardson in the chair.—Fourteen members were admitted by ballot. The society by resolution testified their respect for the memory of their late President, Earl Russell, and the Secretary was requested to convey to the Countess Russell an expression of the society's condolence on the death of her husband. Mr. Hyde Clarke read a paper "On the Settlement of Britain and Russia by the English Races." Dr. Rogers read a paper, by Mr. H. H. Howorth, "On the Columban Clergy of North Britain."

ANTHROPOLOGICAL INSTITUTE.

June 11th.—J. Evans, Esq., President, in the chair.—Dr. J. Beddoe read a paper "On the Bulgarians," referring more especially to the skull-form, on which he quoted Virchow and Kopernicki, but gave also some observations of his own. Not one of sixteen skulls hitherto examined, and procured in different districts of Bulgaria, presented anything like the true Slavonic type, though a few slightly approximated towards it. Almost all were of a cylindrical form, with a considerable parieto-occipital development and a low narrow sloping frontal region; there was an absence of frontal and parietal bosses; the skulls inclined to be long, except those few which indicated an admixture of Slavic type. The majority nowise reminded one of either the Slavic or Turkic form, nor were they much like Esthonian skulls, but they were probably rather Ugrian than anything else. In some of them the great degree of prognathism, the deep nasal notch, and horizontal nasal bones reminded Virchow of the Australian type. If the physique of the Bulgarians was a difficult and obscure subject, their *morale* presented its own difficulties. They differed from the Serbs in some points favourably, in more, perhaps, unfavourably; and though some of their worst faults were, doubtless, what naturally arose in a subject race, they could not all have originated in that way. The heroic type which appeared among the Serbs, whether they were Mussulman, Rayah, or free Christian, and culminated in the splendid barbarians of the Montenegro, was absent here. There was no chivalry, but mere ferocity, in their ballads. Their religion was little above Fetishism, and had little connection with morality. Manliness, generosity, truthfhlness, and respect for women were scarcely to be expected of such a people. But ambition was there, and industry and acquisitiveness, to a degree not found among the Serbs; and the desire of knowledge was there, and the capacity to learn, and but for the interference of Russia, and the vast amount of moral and physical evil brought about thereby, they might gradually, under a government which, though faulty, was improving, have developed into better things. Miss A. W. Buckland read a paper "On the Stimulants of the Ancients and of Modern Savages." A paper by Mr. John Sanderson was read "On Polygamous Marriage in South Africa."

LINNEAN SOCIETY.

June 20th.—Prof. Allman, President, in the chair.—Mr. W. Cattell was elected a Fellow. Dr. J. G. Jeffreys exhibited specimens of a new species of Virgularia dredged in the Osterfjoid, Norway. Some gourds, probably the fruits of *Lagenaria vulgaris*, from Pekin, were shown by Mr. J. R. Jackson. These, which were quite ornamental in pattern, had had their peculiar figure given them while in the living state by the young fruit being inserted in moulds, thus producing the shape desired. A "Notice of some shells dredged by Capt. St. John, R.N., in the Korean Strait," was read by Dr. J. Gwyn Jeffreys. Of fourteen species enumerated, six are now for the first time found living in the North Pacific as well as the Atlantic. *Nucinella ovalis* and *Kellia pumila*, hitherto supposed extinct, are thus shown as recent and living in the Korean region. Six other species are already known as inhabiting both oceans. No less than nine of the fourteen species are Coralline Crag fossils. The author finds this collection supporting his formerly expressed view, that mollusca common to the North Atlantic and North Pacific Oceans may have originated in high northern latitudes, and have found their way to Japan on the one side and Europe on the other by means of the bifurcation of the great Arctic current. Mr. C. B. Clarke read a paper "On two Kinds of Dimorphism in the Rubiaceæ." The group in question is well known to be largely dimorphic; variations chiefly consisting in the length of the style and stamens. The author now records dimorphism as follows:—(1.) Where the point of the insertion of the stamen is altered, being situate in one form high above the middle of the corolla tube, and in another form at the base of the corolla tube—that is subepigynous instead of epicorolline. (2.) There are two kinds of fruits, viz., (*a*) a large fruit corresponding to sessile flower, &c., and (*b*) a small fruit corresponding to a peduncled flower. The Secretary read for Capt. W. Armit "Some Notes on the Presence of Tachyglossus (=Echidna) and Ornithorhynchus in North and North-East Queensland." It is stated that the Echidna occurs at Bellenden Plains, 18° S. lat., which habitat appears to be the most northern limit yet recorded in the Australian continent. The Ornithorhynchus is also met with 150 miles west of Georgetown, and on the Leichardt river, about 18° S. lat. Some remarks on the Echidna skull accompanying the above paper were read by Dr. J. Murie. Its comparison showed that it agreed in all respects with that of the common *E. hystrix*, and that supposed to be specifically distinct, to wit, the *E. setosa.* The New Guinea Echidna (*Acanthoglossus Bruijnii*) presents marked characteristic differences, in skull and otherwise, from both. Prof. Oliver communicated a paper, by Mr. N. E. Brown, "On the Stapeliæ of Thunberg's Herbarium and Descriptions of New Genera." Of eleven species of Stapelia of Thunberg's determination, five only properly belong to the genus as now understood, and six belong to five different genera, two of which (Trichocaulon and Diplocyatha) are now characterized for the first time. *Sarcocodon speciosum*, from Somali land, and *Huerniopsis decipiens*, from South Africa, are curious plants, the genera and species receiving a formal description. The abstract of a paper "On the Shell of the Bryzoa," by Mr. A. W. Waters, was taken as read. The main points of "Observations on the White Whale (*Beluga leucas*) exhibited at the Westminster Aquarium" were given orally by Dr. J. Murie. These referred to the times and manner of breathing, certain outward peculiarities, visual organs and movements of body and tail in progression round the tank, along with other physiological topics. Respiration in and out of the water is not identical as to times and manner. A fungus (*Saprolegnia ferax*), that lately known as the "salmon disease," grew abundantly on the body of the whale, and no doubt acted prejudicially to the animal's health.

Carbonisation of Vegetable Matter mixed among Wool by means of Aluminium Chloride.—This process, invented some years ago by M. Joly, of Elbeuf, says the *Deutsche Wollengewerbe*, is decidedly superior to those in which free acids are employed, as the colours are not attacked, and there is no fear of stains. The wool is impregnated with a solution of aluminic chloride at 6° or 7° Baume, drained in a centrifugal, and dried in a stove at 100° to 125°. It is afterwards washed to remove the chloride.

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F. W. Campin, Sec.

Proceedings of the Institute.

The Institute being now out of Session, no Members' Meeting has been held during the past month.

At the Executive Council, nothing has passed of sufficient importance to call for a report.

Monthly Notices.

The Irish at the British Association.—An Irish correspondent writes to the *Athenæum* murmuring that "first a stranger was appointed President, and then an Englishman has been offered the presidency for next year. There is also a great paucity of Irish among the Presidents, Vice-Presidents, and other officers of Sections. An eminent scientific man proposed that the strangers should be received with all hospitality, but that all Irish papers should be withheld. The reception can scarcely be thought as good as at the last in Dublin, for although the Executive Committee used wonderful exertions, yet the funds were not coming in. The Irish, however, are very forgiving, and after all gave a hearty welcome."

The Yorkshire College of Science at Leeds is advancing very satisfactorily. At a meeting recently it was announced that donations had been promised to the extent of £56,000, and that the College had now 355 students under instruction.

Mosandrium is the name given to a supposed new metal belonging to the Cerium group, discovered by Dr. J. Lawrence Smith, of the University of Louisville, Kentucky. This element was found in the earth Mosandria, is so called after Mosander, who has so thoroughly investigated these rare and curious metals.

On Thursday, the 15th *ulto.*, the remains of Mr. George Morgan, of Streatham, were interred at Norwood Cemetery. The deceased gentleman, if he had survived for five weeks longer, would have attained his 108th year. He was, according to a notice in the *Camberwell and Peckham Times*, a native of Bristol, where he was born on September 19th, 1770. His parents, who were Welsh people, lived to an extreme old age, his father having, it is stated, attained his 98th year. The deceased gentleman enjoyed excellent health until within the last five months, his mental faculties not forsaking him to the last. His youngest son, the only one now living, is 78 years of age, and the grandchildren and great grandchildren known to be living number 115. Mr. Morgan was known as the patentee of several important improvements in carriages, especially in the contrivances for opening and closing landau heads. George IV. and the late Duke of Kent were amongst his earliest distinguished patrons.

A shocking accident occurred at the Thornaby Ironworks, South Stockton, recently. It appears that for some time past the capabilities of a Belgian heating furnace have been tested in the mill department, and a few mornings ago Mr. Thomas Whitwell, one of the partners of the firm, and Mr. John Thompson, an engineer, descended into it for the purpose of making an examination. Whilst they were below the damper by some means got closed, and the result was that the confined gas burst into flame, and enveloped Mr. Whitwell and Mr. Thompson. Both were frightfully burnt before they could effect an escape, and the former now lies at his residence, in Bridge-street, in such a critical condition that little hopes are entertained of his recovery. Mr. Thompson was not quite so seriously injured, and it is expected that he will recover.

Researches on Colour Blindness have recently been made by Professors Cohn and Magnus, of Breslau. More than 5,000 children have been examined by them, and of 2,761 boys there were 76 who suffered from this blindness, or 2·7 per cent. Of 2,318 young girls, there was only 1 incapable of distinguishing colours. Further, a curious fact was established. Among 1,947 Christian boys, 42 were unable to make this distinction, or 2·1 per cent; among 814 Jewish boys, 34, or 4·1 per cent; and among 836 Jewish girls, not one. These results seem to prove that in the case of girls colour blindness hardly exists at all, and that among Jewish boys it is about twice as common as among Christian boys (though local influences might possibly affect the results). In this connection we note that M. Favre has lately been studying Daltonism in France, and he finds there are in that country more than 3,000,000 persons thus affected. The number of females affected is to that of males as 1 : 10. He says that nine cases of Daltonism out of ten may be easily cured in young subjects, the best mode of treatment being methodical exercise upon coloured objects. Mothers should be careful to develop the chromatic sense in their children. Examinations and exercises in colours should be conducted in all schools, &c

The Scientific Review.

SEPTEMBER, 1878.

THE BRITISH ASSOCIATION.

The annual meeting of the British Association for the Promotion of Science was opened at Dublin, on Wednesday, the 14th ult., Mr. William Spottiswoode, F.R.S., presiding. The learned physicist, in his opening address, dealt with the purposes and prospects of the Association, and next with the external aspects and tendencies of science. Under the first head he showed that the Association was general in its comprehensiveness and special in its sectional arrangements, with regard to which latter he suggested they should adopt the dictum of the Frenchmen that "no theory can be considered complete until it is so clear that it can be explained to the first man you meet in the street." As to the society's resources, they had during the last forty-seven years expended in research £44,000. He thought it not difficult to "picture to the mind an ideal future, when science and art shall walk hand in hand together, led by a willing minister into the green pastures of the endowment of research." At present, however, they must be content to select the best men for definite work, and depend on the personal co-operation of leading scientists. On the second and larger portion of his subject the President dwelt at considerable length on the views of Sir Isaac Newton as to the application of mathematics in the investigation of physical phenomena, and he pointed out the progress now being made in reducing the various branches of knowledge, and especially of physical science, to mathematical definiteness and accuracy. Measurements were now all important. An object having a diameter of an 80,000th of an inch was perhaps the smallest of which the microscope could give any well defined representation, and it was improbable that one of 120,000ths of an inch could be singly discerned with the highest powers at our command. But the solar beams and the electric light reveal the presence of bodies far smaller than these. And in the absence of any means of observing them singly Professor Tyndall suggested a scale of these minute objects in terms of the lengths of luminiferous waves. The small bodies with which experimental science has recently come into contact are not confined to gaseous molecules, but comprise also complete organisms, and the same philospher made a profound study of the momentous influence exerted by these minute organisms in the economy of life. In the telephone-plate there was "the solution of that old world problem, the construction of a speaking machine; yet the characters in which that solution is expressed are too small for our powers of decipherment. In movements such as these we seem to lose sight of the distinction, or perhaps we have unconsciously passed the boundary between massive and molecular motion," and almost the only actual measurements yet made were those of the waves of light. There were three matters in respect of which it was thought modern mathematicians had overstepped their legitimate bonds. These were in speculations regarding imaginary quantities, manifold space, and geometry not according to Euclid. Each of these the President vindicated as essential to the pursuit of science and of practical utility. The addition of a fourth dimension to space, for instance, not only extends the actual properties of geometrical figures, but it also adds new properties which are often useful for the purposes of transformation or of proof. Thus it had recently been shown that in four dimensions a closed material shell could be turned inside out by simple flexure, without either stretching or tearing; and that in such a space it is impossible to tie a knot. So also with regard to non-Euclidean geometry, it seemed to expand the ideas of plane figures and to furnish more generalised conceptions as to space. The President, after referring to the calculating machine of Professor James Thomson, by means of which the mere friction of a disc, a cylinder, and a ball is capable of effecting a variety of the complicated calculations which occur in the highest application of mathematics to physical problems, thus summarised his views:—The instances on which we have dwelt are only a few out of many in which mathematics may be found ruling and governing a variety of subjects. It is as the supreme result of all experience, the framework in which all the varied manifestations of nature have been set, that our science has laid claim to be the arbiter of all knowledge. She does not indeed contribute elements of fact, which must be sought elsewhere; but she sifts and regulates them; she proclaims the laws to which they must conform if those elements are to issue in precise results. From the data of a problem she can infallibly extract all possible consequences, whether they be those first sought, or others not anticipated; but she can introduce nothing which was not latent in the original statement. Mathematics cannot tell us whether there be or be not limits to time or space; but to her they are both of indefinite extent, and this in a sense which neither affirms nor denies that they are either infinite or finite. Mathematics cannot tell us whether matter be continuous or discrete in its structure; but to her it is indifferent whether it be one or the other, and her conclusions are independent of either particular hypothesis. Mathematics can tell us nothing of the origin of matter, of its creation or its annihilation; she deals with it only in a state of existence; but within that state its modes of existence may vary from our most elementary conception to our most complex experience. Mathematics can tell us nothing beyond the problems which she specifically undertakes; she will carry them to their limit, but there she stops, and upon the great region beyond she is imperturbably silent.

August 15th.

Section A.—Mathematical Science.

Professor Haughton, F.T.C.D., presided in this section, and in taking the chair said that, in consequence of the illness of Dr. Salmon, which he was happy to say was not serious, the President had asked him to preside and give a few words of an opening address. He believed that of all the sections it was undoubtedly the first. Every branch of science was to a certain extent subordinate to pure mathematics, and it was to a great extent a test of the value of a physical science whenever it was made amenable to figures. Though the labours of the mathematician might seem to many dry and unimportant, yet physical philosophers must recognise the power that mathematicians wield when they find how easily Nature yields her sweets to such implements as the differential calculus, while she resists the mere brute force of experiments. The general conception of the Creator was that He was constantly engaged in the great work of the creation, but it was supposed by Plato that His leisure time was occupied in considering the relations of space, so that, according to him, the most important recreation of the Supreme Being was the subject that was considered in this section. Plutarch told them that that was a saying of Plato's, and at any rate it was a saying that might have been his; and that was as good as most of these classical authorities. The section would have to come in contact with section E, the secretaries of which had been more lively, and had got up earlier and seized some papers on tidal relations which properly belonged to this section. He had sent ambassadors to claim their restoration, but they were informed that section E was very poor in papers, and intended to keep what it had, and to secure as many more as it could. However, section A had some papers on tidal matters, and an arrangement had been come to by which mathematicians who were anxious to hear both series of papers in different sections would have an opportunity of doing so; they would also attempt to make some arrangement with the Geological Section with respect to the amount of time required. Geologists were very extravagant about time, while mathematicians were economic. Some mathematicians offered geologists ten millions of years for the development of their theories, and others asked them, Would a hundred millions be enough; but the geologists shouted, "Nonsense; we shall want a million of billions of years to illustrate the development of such theories as Darwinism." He himself believed that they would require an infinite number of years to develop such a theory. The geologists had been put up to be baited by the mathematicians. He would take no part in this himself unless he saw one side overmatched, and he would then strike in with the weaker party. A friendly conference, however, would be arranged, and he hoped it would result, like the great Conference of Berlin, in an honourable peace. (Applause.) He welcomed the Association on the part of the President to all departments of the University, and for himself gave them a special welcome to Section A. He also thanked Dr. Salmon for selecting him as President in his place.

Papers were read by Mr. Sabine on the motion produced by dilute acids on some amalgam surfaces; by Mr. G. F. Fitzgerald on surface tension; by Mr. Wigham on new applications of gas for lighthouses, illustrated by models; also a paper giving description of two kinds of fog signals—gas guns as fog-signals, with a practical illustration, and the Irish Siren fog-signal—and a new atmospheric gas machine.

Section B.—Chemical Science.

This section met in the Laboratory Buildings, Professor Maxwell Simpson, M.D., F.R.S., president, in the chair. A large number of medical and other scientific gentlemen attended to hear the opening address. The President spoke of the great difficulty of saying anything new on the subject, but, taking into account the value of the knowledge acquired and the discipline of the intellectual faculties in acquiring it, he advocated the importance of giving the study of chemistry a prominent place in our colleges and schools. Many virtues, he claimed, were necessary for the chemist; he must not be discouraged by the force of accident, nor disheartened by the temporary failure of his experiments, nor at the slowness of his processes; above all things he must be true—he must not allow his wishes to bias his judgment. He was glad to see that the importance of original research was as a part of higher education beginning at last to be recognised in this country. The Royal University Commission at Oxford had recently recommended that candidates for higher degrees in science should be required in future to work out an original investigation. In Germany original work had been for at least the last half century a *sine quâ non* for a degree. He thought that another admirable rule by which the professor, who is always selected on account of his distinguished abilities, secures the assistance of the pupils in continuing his investigations. This was a material advantage. To promote original work in this country, he believed it to be indispensable that our professors should be well paid. It would save them from the necessity of supplementing their incomes by commercial analyses, and thus enable them to direct their spare time to original work. He did not approve the plan of appointing a staff of original workers unconnected with teaching, and thought it was much to be regretted that the Universities of Oxford and Cambridge, with such splendid revenues, should contribute so little to the advancement of physical science. His suggestions, however, could not be well carried out unless the Government took into its own hands the appointment to all scientific chairs.

On the motion of Professor Williamson, treasurer of the Association, seconded by Professor Roscoe, of Manchester, a vote of thanks was passed to the President.

The report on the best means of developing light from coal gas by Dr. Wallace, of Glasgow, was read by Dr. Wills, F.R.S. He approved the use of cannel rather than common gas on account of its comparatively small influence on the atmosphere of apartments, and the smaller proportion of sulphur it contains. He also recommended that gas be formed at low pressure, and that district governors be used to ascertain the pressure at different levels in towns. He mentioned the fact that the average illuminating power of gas delivered by the Scotch companies was 26 candles, whereas in London it is only 16, and in the chief cities and towns of England and Ireland only 14. The use of globes round light reduced the quantity 10 per cent.

Dr. Wills read a paper by Mr. Ernest H. Cook, B.Sc., lecturer upon experimental physics at the British Trade and Mining School, on "The Adulteration Act, in so far as it relates to the prosecution of milk sellers." Since the introduction of the Adulteration Act the services of the public analyst had been most frequently called in to decide the question of the adulteration of milk, and he feared they must add that most unsatisfactory decisions were given. Then in other prosecutions instances had occurred in which innocent milk sellers had been fined for selling a pure article, and in very many cases they might be sure the fraudulent dealer had gone unpunished. Milk was a substance which varied greatly in quality. In his own experience he had found a difference of as much as 18 per cent., and Dr. Voelcker had published an analysis in which as great a difference as 25 per cent. occurred. As a result of four years' experience of this subject it appeared to Mr. Cook that milk was subject to a variation owing to the season, a variation owing to the animal, and a variation owing to health. The best milk was given by those cows which were fed on grass, and the better the grass (other things equal) the richer the milk. That the quantity of milk yielded by the same cow varied at different seasons of the year was well known, and the quality also varied considerably. Generally speaking, milk was richer in summer, because the milk producing articles were then available for food, but the variation with the season, he was inclined to think, was due more to the alternation of summer and winter. Some cows gave better milk than others, which might be due to some individual peculiarity of the animal or to the breed. Guernsey was the best breed for quality combined with quantity. Devons produced milk rich in fat, but were inferior to Guernseys. Herefords were good, useful cows, as also were Shorthorns; but the first place must be given to Guernseys. Their milk is richer in solids and in fat, and the butter is of a finer colour. Again, the health of the beast must affect its milk. The course adopted by most analysts was to take as their standard the lowest percentage of solids, or of solids not fat, which it had ever been found to contain; but this was open to objections. By the Adulteration Act the analyst was to fix the percentage himself, and it varied. In order that justice might be done, fraud detected, and the dignity of the chemist maintained, it was necessary to remedy that unsatisfactory state of things. Only one method appeared to offer a chance of success. Briefly, that was to buy and sell milk by quality, instead of by quantity. One method of introducing the practice would be to divide the milk into two qualities, first and second, the former to include all milks containing 12 per cent. of solids, or 9 per cent. of "solids not fat," and to be sold at, say, 4d. per quart, and the latter to include milks containing less than 12 per cent. of solids, or 9 per cent. of "solid not fat." The vendor thus selling according to quality, no unjust prosecution could arise. Some efficient instrument, however, should be put into the hands of farmers and others, so that a rough analysis might be made and the milk sold on the results obtained. This system, the author thought, would tend to stop adulteration, because it would no longer pay to adulterate, a better price being got for the better article, and it would tend to put an end to those complaints of medical men who, after advising their patients to take milk, found its effects so uncertain and unsatisfactory.

Section C.—Geology.

This section met in one of the halls of the new Museum buildings.

The President, John Evans, D.C.L., F.R.S., F.G.S., read an address, in the course of which he said the present was the third occasion on which the British Association had met in this city, its first meeting here having been held in the year 1835. On that occasion, as, indeed, for many years afterwards, the two distinct, though to some extent cognate branches of study, geology and geography, were classed in the same section, and its president was a man of whom Irish science and study may well be proud, and who is still living to enjoy his well-deserved honours—the veteran geologist, Sir Richard John Griffith, the author of the first geological map of Ireland. It seems hardly creditable that the construction of this map was commenced in the summer of 1812, or 66 years ago, but the records of the Geological Society of London testify to the still more remarkable fact that Sir Richard Griffiths was elected a Fellow of that Society in 1808, 70 years ago. When speaking of the geological survey of Ireland it will not, I am sure, be thought out of place if I offer here a tribute of respect to the memory of one who was originally a student in the college within whose walls we are assembled, and who subsequently occupied posts of the highest importance in connection with the Geological Society of Dublin and the Geological Survey of Ireland, besides filling the professorial Chair of Geology in this University; I mean Dr. Thomas Oldham, the late Director of the Geological Survey of India. As to the geology of this country I may observe that we are here assembled just on the edge of that great central plain which forms so important a feature in the map of Ireland, and which stretches from Dublin Bay on the east coast to Galway Bay on the west, with hardly a portion of it attaining to an elevation of 300ft. above the sea, over a tract of country nearly 150 miles in extent in almost every direction. The boundaries of this great plain and those of the carboniferous limestone almost coincide, so that we have here the somewhat remarkable feature of a formation which in England is of such a character as to have received the name of the mountain limestone, constituting in the neighbouring island nearly the whole of the plain country. In some of the north-western counties, however, as, for instance, Fermanagh and Sligo, it assumes its more mountainous character. Nearly the whole of this central plain is overlain with boulder clay, limestone, gravel, or middle drift and extensive bogs, so that subjacent rock is but occasionally seen. In several places detached bosses, old red sandstone, rise through the limestone, and there is also good reason for believing with Professor Hull that the whole of the area was at one time covered with the upper members of the carboniferous group, including the true coal measures, of which, unfortunately, but small patches remain, and those on the margin of the plain. With regard to the mountainous districts surrounding the central plain, we shall, I believe, have the opportunity of visiting some parts of the Wicklow mountains, a district from which a portion, at all events, of the native gold of Ireland was procured in ancient times, as, indeed, it continues to be. Of the abundance of gold in this country in early times, a glance at the magnificent collection of ancient ornaments preserved in the Museum of the Royal Irish Academy will serve to give an idea. Even in times more recent than those in which the bulk of these ornaments were made gold was an important product of this country. There is one point with regard to Irish geology on which it will be well to say a few words, though it is of a negative rather than a positive character. I mean the absence, so far as is at present known, of paleolithic implements in this country. So far as I am aware, no example of any implement belonging to the age of the mammoth rhinoceros and other members of the quarternary fauna has as yet been found in Ireland. Indeed, the remains of Elephas primigenius and its associates are of exceedingly rare occurrence in this country, though they have been found with those of the bear and reindeer in the Shandon cave near Dungarvan. There is, however, one member of that old quarternary group which is far more abundant in Ireland than it is in England or on the Continent of Europe—the "megaceros," which has rightly received the appellation of "Hibernicus." I hope that we may have an opportunity under the guidance of Mr. Richard Moss of seeing some of the remains of this "antlered monarch of the waste," and it will be an interesting question for consideration whether these remains can be regarded as of the same geological age as those of the English caves and river gravels, or whether they do not for the most part belong to what Professor Boyd Dawkins has termed the prehistoric period. It seems by no means improbable that this gigantic stag survived in this country for ages after he had become extinct in other lands, and that the view held by Professor Hull of its extinction being due to persecution by man is correct. If this be so it would seem to follow that the human occupation of Ireland is of far more recent date than that of the sister country. And this brings me to one of those questions which have of late been occupying the attention of geologists. I mean the date which is to be assigned to the implement-bearing beds of the paleolithic age in England. I have always maintained the probability of evidence being found of the existence of man at an earlier period than that of the post glacial or quarternary river gravels; but, as in all other cases, it appears to me desirable that the evidence brought forward should be thoroughly sifted, and all probabilities of misapprehension removed before it is finally accepted. In the present state of our knowledge I do not feel confident that the evidence as to these three successive paleolithic deposits has arrived at this satisfactory stage. The general opinion of physicists as to the probability of a change in the position of the earth's axis has recently undergone modifications. Different mathematicians who have of late gone into the question, as, for instance, the Rev. J. F. Twisden, Mr. George Darwin, Professor Haughton, the Rev. E. Hill, and Sir William Thompson all agree in the theoretical possibility of a change in the geographical position of the earth's axis of rotation being affected by a redistribution of matter on the surface, but they do not appear to be at all in accord as to the extent of such changes. Mr. Twisden, for instance, arrives at the conclusion that the elevation of a belt 20° in width, such as that which I suggested in my presidential address to the Geological Society in 1876, would displace the axis by 10 miles only, while Professor Haughton maintains that the elevation of two such continents as Europe and Asia would displace it by about 69 miles, and Sir W. Thompson has not only admitted, but asserted as highly probable, that the poles may have been in ancient times very far from their present geographical position, and may have gradually shifted through 10, 20, 30, 40, or more degrees, without at any time any perceptible disturbance of either land or water. I have mentioned Professor Haughton among those who from mathematical considerations have arrived at the conclusion that a geographical change in the position of the axis of rotation of the earth is not only possible but probable. In a recent paper, however, he has maintained, notwithstanding this possibility or probability, we can demonstrate that the Pole has not sensibly changed its position during geological periods. His objections are, at first sight, startling, but I think it will be found that, if, instead of drawing great circles through certain points, we regard those points as merely isolated localities in a belt of considerable width, there is no need of fixing the pole of either the Jurassic or the Miocene period with that amount of nicety with which Professor Haughton has ascertained its position. The belt may, indeed, be made to contain the very places on which the objection is founded. Still, the method proposed is a good one, and I hope that as our knowledge of foreign geology extends it may be still further pursued. The President concluded with references to the discovery of paleozoic rocks under London, and to the work of M. Albert Gandez "On the Links in the Animal World in Geological Times," a work which, he observed, will long be a text-book on the interrelation of different orders, genera, and species.

Professor Hull moved a vote of thanks to the President, and, as an Irishman and a geologist, hoped the President would allow him to give him a hearty welcome to Ireland. (Applause.)

Professor Pengelley seconded the vote of thanks, which was carried by acclamation.

Professor Hull then gave a sketch of the geology of the environs of Dublin, in accordance with the custom that a sketch of the district in which the section met should be given immediately after the President's address.

Mr. J. Nolan, M.R.I.A., read a paper on the "Ancient Volcanic Districts of Slieve Gullion."

Mr. W. Mattieu Williams, F.R.A.S., F.C.S., read some notes on the "Glaciation of Ireland and the Tradition of Lough Lurgan."

The other Sections met during the day, and several papers of interest were read.

August 16th.

Biology.

The sub-section of zoology and botany met in the Museum Buildings. The other sub-sections did not meet.

Mr. W. H. Flowers, F.R.S., president of the section, gave an opening address. The subject was "A Country's Progress in Zoological Knowledge." He urged the necessity of naturalists being careful in the use of terms, as great difficulty was experienced by students in consequence of the diversity of nomenclature.

On the motion of Dr. A. Thompson, ex-president, seconded by Mr. Bloomfield, a vote of thanks was passed to the chairman.

The Rev. Canon Tristram read a report of the committee appointed to inquire into the possibility of establishing a storehouse for indigenous animals. It impeached the conclusions of the Fisheries Commissioners as to the Act for the preservation of sea birds, and went into a calculation to show the great destruction by gannets.

Dr. Ray dissented from the report. He came, he said, from the Orkneys. The great destruction was produced, not by gannets, but by the gulls, which were increasing so enormously that they were actually flocking from the rocks to the moorlands.

Dr. George Jefferys concurred in this view.

The Rev. Albert A. Harland remarked that, having visited the Hebrides, he could testify that the only person who knew anything about the Act was a policeman. He had been breaking the law while engaged in collecting specimens for the British Museum, and he suggested that persons who were attending for scientific purposes should have permission to shoot seafowl in the close season.

Mr. Howard Saunders observed that the gannets fed principally on fish. He mentioned as a fact of some interest to Ireland that gannets had migrated in large numbers to an island sixteen or seventeen miles from St. David's, which is nearer to Ireland than to Scotland. As to the destruction of sea fowl, he stated that one party had destroyed in a single season from 45,000 to 50,000 kittiwakes; but as the taste for sea-fowl feathers in ladies' bonnets had declined, there was a chance of the birds escaping in future.

Mr. Bloomfield spoke of the great destruction of plovers' eggs, and observed that if Mr. Harland's suggestion were adopted the number of scientific men shooting birds and of non-paying members of the Association would greatly increase. (Laughter.)

A report was read upon the zoological station established near Naples, to the advantage of which testimony was borne by different speakers.

Papers were read by Dr. G. E. Dobson, "On the Geographical Distribution of the Cheiroptera," and by Mr. J. Rae, M.D., LL.D., some notes on the geographical distribution and migrations of animals on the northern shores and lands of Hudson's Bay, &c.

Geography.

In this section, the President, Sir Wyville Thomson, delivered his address.

A vote of thanks was given to Sir Wyville Thomson for his valuable paper.

The Rev. Mr. Holland read a papper on "A Journey on Foot through Arabia Petræa," and Captain Kitchener a paper on "A Survey of Galilee."

Mr. Molloy, M.A., secretary, read the report of the Anthropometric Committee, and it was resolved that the committee should be reappointed.

A paper on "Canadian Statistics" was read by Mr. E. A. Bateman.

Section F.—Economic Science and Statistics.

In this popular section, which was well attended during the day, the President (Professor J. K. Ingram, LL.D., M.R.I.A.) delivered his introductory address.

Sir James Watson read a paper on the question, "How to meet the requirements of population displaced by the Artizans' Dwellings Act."

Miss Isabella S. M. Todd, of Belfast, read a paper on the boarding out of pauper children.

A vote of thanks to Miss Todd having been passed,

The Rev. Mr. Marshall, chaplain of a workhouse, called attention to certain difficulties in the way of boarding out. The workhouse children were largely illegitimate offspring of persons of the lowest class. The mother in such a case, as in any other, would naturally like to keep her child by her, but the guardians could not in that case entrust the child to her keeping. Yet children reared within the walls of the workhouse could scarcely escape becoming depraved by associating with depraved adults.

Dr. Hancock said this difficulty could only be removed by changing the law.

Section G.—Mechanical Science.

Mr. Edward Easton, C.E., President of this Section, delivered his address, in which he fully reviewed the hydraulic works of the ancients, and then proceeded to state that almost all the great engineers of former generations, who have paid attention to this question, Smeaton, Telford, Rennie, Golborne, Mylne, Walker, Rendel, Stephenson, Jessop, Chapman, Beardmore, and, without mentioning names, many of the most eminent now living, have agreed to the following general propositions:—That the freer the admission of the tidal water the better adapted is the river for all purposes, whether of navigation, drainage, or fisheries; that its sectional area and inclination should be made to suit the required carrying power of the river throughout its entire length, both for the ordinary flow of the water and for floods; that the downward flow of the upland water should be equalized as much as possible throughout the entire year; and that all abnormal contaminations should be removed from the streams. Let me say here that I am more and more convinced that the necessity for providing two kinds of water for the supply of large towns, the one for drinking and cooking, from springs and wells beyond all suspicion and contamination, the other sufficiently clean and soft for general purposes, will be gradually forced upon us as population increases. I also wish to remark that artificial compensating reservoirs may be much more frequently made use of than is generally supposed to be possible, when it is considered that, so long as the dams are constructed in situations where there is no danger of their giving way, it is by no means necessary that they should be watertight, and that, therefore, they can be constructed at a very much smaller outlay. In fact, the purpose would be answered by a series of open weirs, which would collect the water in times of flood and discharge it gradually down the stream. The example of our French neighbours in the more general use of movable weirs—*barrages*—of various construction could, I am satisfied, be followed by us with very great advantage in many cases. The question of water power is one which I think deserves more consideration than it has lately received. It has been the fashion to consider that small watermills are of little or no value, and in the present state of most rivers and streams, this is to a very great extent true, but only because the supply of water to work them is so variable and uncertain. Sufficient attention has never yet been given to the subject of the amount of compensation water which must be given for the use of riparian proprietors when the watershed areas are dealt with for the purposes of water supply. There is a kind of empirical rule acknowledged by most of the eminent water engineers, that one-third of the average flow of three consecutive dry years is a fair equivalent for the abstraction of the water falling on a gathering ground. I am strongly of opinion that, looking to imperial interests, advantage should be taken of every opportunity of dealing with a gathering ground to provide for a much larger proportion of its available water being sent down the stream, so that the natural water power of the country may be properly developed. The extra cost of the necessary works must, as a matter of course, be borne rateably by the interests benefited. It is certain that with the progress of invention many more ways of utilising this power will be discovered. At present, through the medium of compressed air, of hydraulic pressure, and of electro-motors, the great disadvantage of its being only available at the spot where the water runs is overcome, and the power can be transmitted to any distance, and used wherever it may be most conveniently applied. Sir Robert Kane, in his most valuable and exhaustive work on "The Industrial Resources of Ireland," has given an estimate of the value of the power allowed to escape every year in the shape of floods, and the same calculation might be applied to the sister kingdom. It is probably no exaggeration to say that where running streams exist the power required for estate purposes, on the majority of properties in the United Kingdom, might be obtained by a proper conservation of the natural water resources of those streams. The consideration I have been able to give to this subject has helped to convince me that, although a vast amount of labour and research has been devoted to it, it is, nevertheless, one in which a "more systematic direction to systematic inquiry" is urgently needed. A vast collection of scientific facts exists, but they require arrangement and collation, and future observations should be more strictly classified, so that the bearing of each one, both on the others and on the subject at large, may be properly appreciated with a view to a practical result. In France this is being done to a very large extent, and an excellent map showing the phenomena of the rivers and streams of that county is now in course of preparation. For many years, also, very accurate observations of the phenomena of the whole of the basin of the Seine have been taken, and have been centralised (*centralisées*) by that eminent engineer whose loss all who had the privilege of knowing him either in his work or in private intercourse are deploring, M. Belgrand, late Inspector-General of the Ponts et Chausées, and by his able coadjutor, M. M. G. Lemoine. These observations have been published in the form of diagrams, admirably in their simplicity of design, which show at a glance the bearing of every one of those phenomena on the general character of that river. In Italy, also, where there exists a distinct department having control of the hydraulic works of that country, the same exhaustive system of collation and record has been followed, and the results have been published in a series of tables. In Germany, although the same complete system is not in vogue, its chief river has been the subject of most thorough investigation, the results of which have been published in a beautiful map of the Rhine and its regulating works. In our own country, as might be expected from the number of engineering works which have been executed, there probably exists an amount of detailed information on special and often minute points which is unsurpassed, and probably unequalled in the world. The President then proceeded to advocate the establishment of a new department, one not only endowed with powers analogous to those of the Local Government Board, but charged with the duty of collecting and digesting for use all the facts and knowledge necessary for a due comprehension and satisfactory dealing with every river-basin and watershed area in the United Kingdom; and concluded by stating his firm belief that an intelligent management of watershed areas would be compatible with an absolute profit to every interest affected; that we have here no question of give and take, but that in this, as in every other case, the laws of Nature, under proper and scientific regulation, can be made subservient to the needs of the highest civilization.

AUGUST 17TH.

SECTION B.—CHEMICAL SCIENCE.

This section met in the Laboratory Theatre, Professor Maxwell Simpson, M.D., F.R.S., in the chair.

Dr. J. H. Gladstone, F.R.S., read "Notes on Aluminium," the result of observations made conjointly with Mr. Tribe in 1876. The authors had described the action of aluminium and iodine on alcohol, and two new compounds resulting from it. One of these—the aluminic ethylate—was exhibited, and it was shown that it could be melted and boiled off; the vapour on being ignited burning with a luminous flame, and giving off fumes of alumina. The author also produced evidences of a similar reaction with methylic alcohol, and exhibited specimens of an amylic compound, and of a pure aluminic butylate, also capable of distillation, and closely resembling that previously described, from common alcohol.

Other papers were read by Dr. Emerson Reynolds, Sir W. Thomson, F.R.S., and Dr. Edmund W. Davy.

SECTION C.—GEOLOGY.

The section resumed its sitting in the New Museum Buildings, Professor Evans, President, in the chair.

Professor W. Pengelley read a paper on the exploration of Kent's Cave, situated in a hill in the neighbourhood of Torbay, Devonshire; the 14th report of the committee for exploring Kent's Cavern. He mentioned that the first man who drew attention to the cavern and excited an interest in it among geologists was an Irishman, a Roman Catholic priest, who resided at Torquay. After giving the dimensions of one portion of the cavern, named the Bear's Den, he stated that on entering a chamber leading from it the floor was found to be a complete pavement of blocks of limestone, some of them of considerable size. Their removal disclosed an almost horizontal bed of the typical breccia, the most ancient deposit yet found in the cavern. The only objects of interest found in the chamber were four pieces of bone, which he exhibited, and of which he had over 7,000 boxes of specimens taken from this cavern. Another part of the cavern, called the Tortuous Gallery, yielded 29 teeth of bears, several of them in pieces of jaws, one tooth of a horse, several bones and pieces of bone, three bits of coarse friable black pottery, and a piece of black flint. In the part of the cavern called the under vault were found 47 teeth of bears, 33 of hyena, and two of fox, numerous bones and fragments of bone, and the greater part of a large quartzite pebble. Many of the teeth of both bear and hyena were in jaws, or portions of jaws.

Professor Boyd Dawkins said they generally found Arctic animals like the reindeer and glutton associated with animals belonging to warm climates. The probable cause was that there was a gravel structure of land over the greater part of the new subterranean area from the north of Africa over the region of Europe, until it finally reached Great Britain and even Ireland. This would afford a means of emigration to animals northward and southward, according to the season.

Thanks were voted for the paper.

Mr. R. H. Tiddeman read the sixth report on the Victoria Cave, in Settle, Yorkshire. It contained a correction by Professor Buck of a diagnosis on an ursine fibula which he had mistaken for human bone. The preglacial existence of man must, therefore, rest on other evidence. The committee claimed that the bones referred to were not the only ones found in the Victoria Cave, and the evidence which had been obtained was not to be lightly set aside.

Professor Dawkins disputed the notion that the antiquity of man was to be settled one way or the other by the discoveries in the cave. He dissented from the views of the committee. There was an immense amount of untrustworthy evidence on the subject laid before them. The caves had not produced one specimen of sheep or goats in connection with the extinct animals, and the whole evidence showed that they were not living at the time of the extinct animals. He criticised some of the remains, remarked that the cuts in the bones were probably caused by a sharp instrument, and accounted for the presence of the sheep and the goats by the simple suggestion that the animals were dropped from the top deposit and eaten by the people who took refuge in the caves, and thus became associated accidentally with the extinct mammals. (Laughter.)

Professor Hull remarked that Mr. Tiddeman in the North and Mr. Scratchley in the South of England, who advocated the theory referred to, always had two strings to their bow, and when one piece of evidence broke down they said they had found something else since. The *fibula* had now become *fabula* (laughter); but Mr. Tiddeman said they had something more valuable in the scratching on bone.

Mr. Pengelley cautioned geologists against drawing conclusions upon any but the best evidence, and reminded the audience that Professor Dawkins's remarks bore only on the question about the cave, and not on the general question.

The President remarked, as an example of how fallacious such discoveries were, that he had himself found a coin of the year 1826 beside the skeleton of the men supposed to belong to the early period and buried 2000 years. (Laughter.)

Mr. V. Hall read a report on the geological map of India, which showed that there are 8000 square miles of coal of an inferior quality. It was unfortunately situated, however, in a most inaccessible part of the country. The map will shortly be published.

The fourth report of the Underground Water Committee was read by Mr. De Rance, F.G.S., Assoc. Inst. C.E.

BIOLOGY, &C.

Dr. A. F. Andrews read a paper on a case of commensalism in the holothusia, or trepung, as the natives call it, a fish which is found in the Chinese Sea, and is used by the Chinese in making soup. The peculiarity of the fish is that other fishes live in it. He saw instances of living fish entering the trepung. The ova of other fish are deposited in the stomach of the trepung, and are there developed and sustained by the same nourishment. When the fish thus germinated afterwards re-entered the home of their infancy they cause the death of the trepung.

Sir Victor Burke read a paper on certain osteological characters in Cervidæ.

Sir John Lubbock read a paper, which attracted much attention, on the habits of ants.

ANTHROPOLOGY.

Professor Huxley made some introductory remarks, in which, amongst other matters, he said:—When I first knew the British Association the *locus* of disturbance in it was the Geological Section. All sorts of terrible things about antiquity of the earth and I know not what else were being said there, which gave rise to terrible apprehensions. The whole world, it was thought, was coming to an end, just as I have no doubt that if there were inhabitants in Antrim in the middle of the tertiary epoch when those great lava streams burst out they would not have had the smallest question that the whole universe was going to pieces. Well, the universe has not gone to pieces. Antrim is, geologically speaking, a very quiet place now, as well cultivated a place as one need see, and yielding abundance of excellent produce; and so, if we turn to the Geological Section, nothing can be milder than the proceedings of that admirable body. All the difficulties that they seem to have encountered at first have died away, and statements that were the horrible paradoxes of that generation are now the common-places of schoolboys. The present *locus* of disturbance is, I hear, to be found in the Biological and more particularly in the Anthropological Sections. History repeats itself, and precisely the sort of terrible apprehensions which were expressed by the aborigines of the Geological Section in long far back time are at present expressed by those who attend our deliberations. Finally, we come to the very interesting question as to whether, with such evidence of the existence of man in those times as we have before us, it is possible to trace in that brief history any evidence of the gradual modification from a human type essentially similar to that which exists at the present day to a human type somewhat different from that which now exists. I am free to confess that my opinion on this matter remains exactly what it was some some eighteen years ago, when I published a little book which I was very sorry to hear my friend Professor Flower allude to yesterday, because I had hoped it would have been forgotten in the greater scandals of subsequent times. (Laughter.) I did there put forward the opinion that what is known as the Neanderthal skull is of human remains that which presents the most marked and definite characteristics of a lower type. Using the language in the same sense as we would use it in other branches of zoology, I believe it to belong to the lowest form of human being of which we have any knowledge, and we know from remains accompanying that human being that, as far as all fundamental points of structure were concerned, he was as much a man and could wear boots as easily as any of us, so that I think the question remains pretty much where it was. I do not know that there is any reason for doubting that the man who existed at that day could not have been in all essential respects similar to the man who exists now. We have no more reason for thinking that it is unlikely than we have for objecting to the positive evidence which we possess that the horse which existed at that time was in all essential respects identical with the horse which exists now. We do happen to know that, going back further in time, the horse presents us with a series of distinct modifications and evolutions, by which it can be traced back from an earlier type. Therefore, it must be deemed possible that man is in the same position, although the facts we have before us with respect to him tell in neither one way nor the other. I have now nothing more to do than to thank you for the great kindness and attention with which you have listened to this very disconnected talk. (Applause.)

GEOGRAPHY.

The principal paper in this section was one by Mr. J. S. Phene, F.S A., on "Some Geographical Variations on the Coast of France."

ECONOMIC SCIENCE.

The subjects discussed in this section, which was presided over by Dr. Ingram, related exclusively to the Irish Land Question. It was presented in every possible phase, and the papers were chiefly reproductions of views expressed in the Statistical Society and in public reports.

MECHANICAL SCIENCE.

Mr. W. H. Wheeler read a paper on the drainage of the Fenland, considered in relation to the rivers of Great Britain. The subject was treated in the paper under the three heads of engineering, administration, and finance. Under the first head it was sought to be shown that the object of all future legislation should be not drainage only, but the regulation of the water supply. The circumstances of our rivers having been altered by the modern system of drainage, it becomes necessary to adopt their channels to carry a vastly increased supply of flood water at uncertain and distant intervals, and during the intervening period to discharge the diminished regular supply in such a way that the channel may not become choked by reeds and shoals, yet be made available for storing a supply of water in lieu of that which formerly percolated slowly through the soil. To effect this, a modification of the plan of waste lands, adopted by the old engineers, is suggested, the river proper being adapted for the ordinary summer and winter flow, and the flood banks to be set back sufficiently distant from the channel to leave a cess or margin to receive the flow of the greatest floods. The space left between the ordinary channel and the banks being only covered by water occasionally would, like the waste lands, afford valuable pasturage. Each watershed of a main river should be subject to one conservancy board. The whole watershed being divided into districts, the area of which is to be determined by the watersheds of tributary streams or other physical channels, the sub-districts are to be placed under the jurisdiction of commissioners, elected by the occupiers of the land in proportion to their rateable value, and who shall have the charge of all local interests; the general conservancy board to be elected from among the members of the district boards. The means of carrying out improvements required for future administration and maintenance should be provided by a tax on the rateable value of the whole area of land within the watershed, whether rural or urban, as every acre of land receives and contributes its *quota* of the rainfall, so it should fairly provide its share of the cost of maintaining the channels for carrying this off. The objection that high lands can never be injured and are so far away from the flooded districts that they do not require any improvement of the rivers, is met by the answer that it is owing to the drainage carried out on these very lands that water is not poured so rapidly into the river as to cause the floods, and they ought, therefore, fairly to contribute towards the remedy for the evil they have caused.

A discussion was taken on the general subject—river control and management; dealt with in the papers read yesterday and this morning.

Sir John Hawkshaw was first called on by the President. He said the papers which have been read raise some engineering points, but, beyond laying down a few well-understood engineering rules, little can be done. In this way there will be a general application. Every river will require special examination and study, and often a different treatment, and the most valuable information in this respect will be derived from the statement of the successful treatment of some particular river. The papers that have been read seem to agree on one point—viz., the rivers should be placed under better control. To what extent Government should interfere requires grave consideration. Last year the Government appointed a Committee of the House of Lords, which was presided over by his Grace the Duke of Richmond, and comprised some of the ablest Peers, who, after taking evidence, reported their views on this matter. The Committee did good service, and to this extent, and in this manner, it is clear the Government can act with advantage by indicating the direction legislation should follow. They may, with advantage, also take such steps as will tend to dimini the cost of legislation to the parties interested, and there are cases in which they may exercise a gentle pressure. How much further they might go I am not at present prepared to say.

Mr. Manning had only to respect what had fallen from Sir John Hawkshaw, as to the very great unanimity in the opinion expressed on this subject. One might almost imagine that the president had held a committee in London, at which it was agreed that all speakers at this meeting should be unanimous. (A laugh.) He could only say that he was not on the committee, but he perfectly agreed with all that had been said. There could be no doubt of the necessity of having a general conservancy board, not cramping local action at all, but guiding and directing it. In his opinion nothing short of that would do.

Mr. John Smyth, as Engineer of Bann Reservoir Company, had listened with great pleasure to the papers. He wished to point out the importance of having reservoirs provided, as much as possible, for all the rivers and their tributaries, not only for storage, but also for the purpose of mills, and for the supply of towns. He thought it would be very important to have rivers under one control, because so many conflicting interests were growing up every day, that eventually the use of rivers would be lost altogether unless some system of that kind were adopted.

Mr. James Price wished to offer a few observations on some of the points dwelt on One was as to the districts that should pay for the drainage. He could not entirely agree with what had been stated in the papers of Mr. Hawkshaw and Mr. Wheeler —that the whole drainage area of a district should pay rateably for the improvement. He thought it would be hard on the owners of the property who happened to have land high and dry, and quite independent of the benefits to be derived from the drainage operation, that they should be obliged to pay as much as the owners of land directly benefited by it; but he admitted that they ought to pay something. One consideration, bearing upon the propriety of requiring all to pay something, had not been remarked upon. It was the effect of drainage upon the climate generally. It could be satisfactorily proved that Ireland suffered to the amount of at least three degrees of summer heat in consequence of defective drainage. There was a large quantity of undrained land in the basins of the Shannon, and some acted as the envelope of a wet bulb thermometer, and in fact wasted two or three degrees of heat of the summer sun in evaporating the water which might be employed in ripening the crops. In addition to the advantages conferred by railways in enabling large draining districts to be visited, he desired to mention those of the telegraph. He had had charge for a great many years of one of the leading canals in Ireland supplied by a lake of 2,500 acres, which had no other outlet, and was subject to some peculiarities, and he believed that but for the use of the telegraph it would have been impossible to have controlled it.

Mr. H. Law had to express his entire concurrence with the expediency of putting rivers under more general control than at the present time. One of the most important reasons why a general control of the whole of the watershed or valley of the river should be adopted was that the work, for the improvement of the river, whether for drainage or navigation, or other purposes, would be carried out in a certain order. It was almost impossible where there was a large number of local authorities to move them to take those steps in right order and in concert. He might say that as regards England the Public Health Act of 1875, so far as river works were concerned, divided the whole country into areas which had no significance whatever as to the question of level, which especially should determine the area, but were determined merely by the political boundaries of boards of guardians. He knew dozens of cases in which no more serious delays, complications, and preventions of useful works had arisen than from that very cause. With regard to rating, he quite concurred in the principle, stated by Mr. Hawkshaw, and supported by others, of a universal rating being necessary, proper, and equitable. All persons would benefit by the general improvement, and it would be impossible to draw such nice distinctions as to the amount of a rate as to make it entirely equitable over the whole area. The broad principle which had been recognized in the Public Health Act of making a rate over the whole district was the best to adopt.

Mr. Symons, referring to the question raised by Mr. Price—that the temperature of Ireland was lowered by the waste of heat in evaporating water from bog lands—thought a good deal might be said on both sides; but he might mention a fact in support of the view of Mr. Price. Last spring they had in the north of London a tremendous rainfall, 3½in. in the course of a couple of hours, and immediately following that there came an excessively hot week, and the temperature of the south of London was 4½ degrees higher than in the north. As to the advantages given by the telegraph to a central officer controlling the sluices and barrages along a river, there could be no question that the damage from floods might thus be reduced, at any rate, by one-third, a reduction which would far more than compensate for the cost of appointing such an officer and putting up telegraph wires; and not only would such an officer know the actual amount of water in the different basins or sections of the river, but the system might be carried much further. Information of the heavy rains which sweep across the country could be telegraphed from station to station as they pass from west to east, and by this means the watercourses might be put in readiness, and when the rain came it would simply find an empty channel to flow in, instead of a full one to overflow. There was no doubt that much mischief had been done by choosing what had been appropriately termed political boundaries for river districts. He was glad to say that the Social Science Association was already moving in the matter, and he thought he was correct in stating that a petition had been sent in to Mr. Sclater-Booth urging the propriety of substituting for the present very arbitrary sub-divisions the watershed areas of the country. As to utilizing the existing boards, for which some of the speakers entertained, perhaps, a greater veneration than he did himself, it seemed to him to be a fatal objection that those boards existed for entirely different objects. Sir John Hawkshaw had said that we ought not to call upon Jupiter to help us, but work for ourselves; but there was one thing which Jupiter could do for us, and which we could not do for ourselves, and that was to collect in a definite form, the *data* which exist upon hydraulic questions in this country. (Hear, hear.) He felt most strongly that if a central board did nothing else than classify and collect the information which already existed, it would far more than repay any cost entailed by its establishment.

Mr. Deacon was prepared to bear witness to the very great difficulties arising from conflicting interests which every one who desired to touch the existing condition of rivers had to deal. In many cases no two of the various classes of authorities had any interest in common in any one condition of the river, and the difficulty experienced in getting them to agree on any particular treatment of a river was, therefore, not to be wondered at. Exact measures would require exact statements in evidence, and these were not always convenient; but there would be no difficulty in fixing every few miles gauges which would go by themselves for at least a month, and draw continuous curves of the behaviour of the river for that time. As to obtaining a sufficient water supply, it was a fact that 25 gallons per head per day given to the whole of the population of England and Wales would not abstract from rainfall more than about 1 per cent. of the total overflow after excluding flood waters, so that the obtaining of a sufficient water supply for the present and future population was only a matter of engineering intelligence.

Mr. Kelly objected to the proposition that the drainage rate should be universal. For instance, why should a grouse mountain be taxed for the drainage of valley lands? What would be thought of a bailiff levying a distress on the Himalayas for a tax for the drainage of the Jumna or the Ganges?

Captain Douglas Galton thought it was perfectly clear that the time had come when, if we were to utilize our water supplies to the fullest extent, we ought to have them very much more looked after by some central department. He quite agreed with Sir John Hawkshaw that it was undesirable to have the construction of works for the regulation of rivers placed under a Government department; but he thought that while on the one hand we should place the whole jurisdiction relating to each river under Conservators, as had been done with the Thames, which he believed to be likely to be followed by the best results, leaving to those Conservators the duty of raising the money from the local area affected, and employing those engineers whom they thought best qualified; yet, on the other hand, there should be some central department of the Goverment charged with bringing all those matters to one focus, collecting information and seeing that the various river interests were all placed under proper Conservators.

Mr. B. Stoney was greatly pleased at the unanimity of all the speakers in favour of legislation on this subject. He quoted from an address delivered by himself when President of the Local Institute of Civil Engineers, to show that he then held the opinion which he still retained of the necessity of constituting a central authority for the control of each main river.

Mr. Clarke Hawkshaw was glad to find they were all so nearly agreed among themselves, and still more so to find that members of sections who had kindly listened to them were not inclined to disagree with them. With respect to the drainage-tax, he had distinctly stated his opinion that the flooded districts should, in the first instance, be charged at a higher rate; but when once the works were carried out he thought the rate over a large district would be so small that it would really be hardly worth while to divide it.

Mr. Dillon said with regard to Ireland there would be great difficulty in applying the principle, that the whole watershed should be taxed, because for about 50 years the people had been educated into the belief that it was only the injured ground that should bear the taxation, and there would be an enormous amount of opposition to any proposition for taxing the whole in the case of a property situated on the division between watersheds. The injustice would be manifest if one half of the property lay in a watershed in which there was no flooded ground and the other half in a watershed where flooded ground existed.

Mr. Shelford, adverting to the rural sanitary districts as possessing political rather than physical boundaries, mentioned that recently a scheme for a double sewer was brought forward by some combined authorities in Kent. The Local Government Board, though requested, did not dare to divide the parishes according to the watersheds for the purposes of rating, but when the Bill came before Parliament this was done.

Mr. Lucas was afraid that the unanimity apparent among them would be found on examination to be very partial and only to apply to certain points, such as the necessity of appointing Conservancy Boards on broad principles; but a considerable amount of vagueness existed as to the nature and constitution of those bodies, and it still remained for the authors of various papers to agree upon some settled plan which should be subscribed to and printed before Government was addressed on the subject. For his part he should be very sorry to see so large a measure undertaken by Government as had been proposed by their president, for history and experience showed that the sudden creation of large institutions had proved a failure. If the water question and all allied question were to be a success, it should begin with some comparatively small measure such as the establishment of a simple survey not going beyond that in the first instance.

Mr. Wheeler thought that in this case it was absolutely necessary that the Government should bring in some measure to make the management of rivers compulsory.

Mr. Easton said that to a certain extent the suggestion pleasantly made by Mr. Manning was quite true. He had asked many gentlemen to contribute papers to the section on the same subject which he had himself chosen for his address; but he did not know beforehand how the different writers intended to treat the subject, and he was very glad indeed to find so general an agreement in a discussion that had occurred. Almost all the speakers and writers of papers had agreed in this, that at present there was felt the want of trustworthy *data* existing in this country, and he was glad to find that several of the writers of papers had gone a little beyond the wish to have the gentle pressure which Sir John Hawkshaw spoke of upon the Government, but would rather make it a little more fatherly and compulsory in its action on the different authorities. At the same time he should not for one moment wish to see the internal Government of the streams taken out of the hands of those who were most interested in them, and who must of necessity know most about that matter. On the rating question he agreed with Mr. Wheeler that it should be universal, being regulated of course also as Mr. Clarke Hawkshaw had suggested.

Mr. Symons read a paper on the rainfall of

Ireland, which was followed by a short discussion in which Irish country gentlemen were urged to take a greater interest in ascertaining the rainfall.

Mr. H. Law read a paper on the discharge of sewage into tidal rivers. This subject was one of not only general importance, but was of special interest in connection with the pollution of the river Liffey. It was the more desirable that this subject should be brought forward for discussion, because in connection with the discharge of the sewage of London into the Thames it had been recently stated by those who might be regarded as authorities on the subject, that the composition of the water of the river was more than half sewage, and that the percentage of sewage was ever increasing. A river might be regarded as an elongated reservoir which received water of three different qualities—namely, river water, or that derived from surface drainage and land springs; sea water, entering with the tide; and polluted water from the sewers, or sewage. The author then proceeded to state the actual mean quantities of the water from these several sources, and showed that the average composition of the Thames water was as follows:—sea water 98·91, river water 1·02, sewage 0·07; total 100·00. In conclusion he pointed out the conditions under which sewage should be discharged into tidal rivers.

Mr. Mindon Stoney read a paper on recent improvements in the port of Dublin, in the course of which he observed that the trade of few harbours in the United Kingdom had made greater relative progress within the last 20 years than that of Dublin. During this period of 20 years the tonnage entering the port had much more than doubled. In 1857 it amounted to 880,884 tons, and last year it rose to 1,973,781 tons, while during the current year there was a good promise that it would surpass the 2,000,000 limit. While the tonnage of Liverpool and Glasgow had respectively increased 50 per cent. in the last 20 years, those of Belfast and Cork had nearly doubled, and that of Dublin had considerably more than doubled in the same time. The tonnage of Glasgow was only one-fourth more, and that of Liverpool was not four times greater than that of Dublin. He described the works carried on by the Port and Docks Boards for improving the port. It was determined, after mature consideration, to extend the north wall and construct a large tidal basin, with 24ft. along the river face, so as to float the largest commercial vessels at all states of tides. The masonry was commenced in 1871, and up to the present about 2,500 lineal feet of wall had been built on a novel principle, which avoided the trouble and expense of coffer dams, pumping, staging, and other temporary works, the expenpiture on which frequently exceeded the cost of the permanent work to which they were merely auxiliary. The new mode of construction consisted in the use of blocks of masonry of unprecedented size in the foundation below water level. Each block was 29ft. high, 11½ft. long, and 21ft. 4in. broad at the base, and weighed 350 tons. They were built on land. About three months after completion they were lifted by powerful floating shears and conveyed to their destination in the quay, where each block formed 11¼ft. in length of the lower portion of the wall as far as low water level, and when a number of these blocks had been thus laid in position the superstructure up to coping level was built over them in the usual manner by tidal works, the total height of the wall being 45ft. Besides the large floating shears for lifting and moving the blocks about, there was one other special appliance—namely, a diving bell, also unprecedented in size and peculiar in construction. This bell, which weighed 90 tons, was used for excavating and levelling the river bed on which the blocks lay. The chamber was cast iron, 20ft. square and 6½ft. high, with a tube or funnel 3ft. in diameter, and rising to a height of 44ft. over the bottom of the bell. This was the greatest depth of water in which the present bell was intended to be used, though by adding to the length of the funnel it might be worked in greater depths. The upper end of the funnel formed an air lock, 6¼ft. high, with double doors and suitable cocks for admitting the compressed air from the chamber into the lock, or for letting that in the lock escape into the external atmosphere, and by this arrangement the workmen could pass up and down without lifting the bell off the bottom or stopping the work of excavation. Inside the chamber were two large iron trays, and the men shovelled the excavated earth into these trays. When they were filled the bell was lifted a few feet off the ground, and the barge hauled some yards to the rear of the wall, where the trays were discharged by pulling out a detent, when the barge was brought back to its working position, and the bell lowered as before. The discussion on the paper was adjourned.

(*To be continued.*)

Further Liquefaction of the Gases.—Studying the compressibility of acetylene, Cailietet observes a marked departure from the law of Mariotte in its behaviour, and, pushing the condensation still further, succeeded in liquefying it. The apparatus consisted of a hollow steel cylinder, thick enough to resist a pressure of several hundred atmospheres, having screwed into it at the top a bronze collar carrying a thick glass reservoir closed above, and continued downward by a larger tuke, open at the bottom. This glass tube contains the gas to be liquified, its lower end dipping below the surface of mercury up into the tube, compressing the gas and finally liquefying it in the narrow portion at the top. In compressing acetylene, the temperature being + 18°, numerous droplets are seen to form and run down the walls of the tube, under a pressure of 83 atmospheres. Reducing the pressure gradually, the liquid returns suddenly to gas, filling the tube for an instant with a thick fog. Liquid acetylene is colourless and extremely mobile; it appears to be highly refractive, and is lighter than water, in which it is soluble in all proportions. It dissolves paraffin and s. Cooled to zero in presence of water and linseed oil, it forms a white compound like snow, which decomposes on heating or lowering the pressure.

German Polytechnic Schools.—There are nine Polytechnic schools established among the German-speaking people, two of which, however, are outside the limits of the German Empire, viz., those of Vienna and Zurich; and the total number of students embraced in these institutions amounted in 1876 to nearly 7000. The majority of the schools contain about 500 students each, but those at Vienna, Munich, and Zurich, the three largest schools, number about 1000 each, a number equal to that of a good-sized German University. They are all State institutions, subject to the control of the Minister of Public Instruction for the State in which each is respectively situated. They also receive considerable sums of public money, which are appropriated for the purpose every year by Government. They are not, however, wholly dependent on State support, but are also enriched by munificent endowments from private individuals. These institutions, unlike the Universities, are all of recent establishment, having grown up to meet the wants of this great industrial age. That they are popular, and that they supply a real want, may be seen in the fact that the attendance in the schools is increasing every year, and also that their number is being added to, as in the case of Berlin, where the Prussian Government has appropriated 8,000,000 of marks (about £400,000 for the erection of a new polytechnic school.—*Cassell's Magazine.*

A JAPANESE BUILT IRONCLAD.

A Japanese ironclad, the Li-ki, five guns, is now on her way to England, making a call at all the principal Asiatic and European ports *en route*. Unlike most of the vessels belonging to the Japanese navy, the Li-ki was built in Japan, under the superintendence and from the designs of M. Chiboudier, a French gentleman employed in the Imperial Arsenal of Yokoska. It will be remembered that the English Government lately made overtures for the purchase of three or four gunboats built in that country for Japan, but were unsuccessful in their bids for the vessels. The visit of a native-built ironclad to Portsmouth is therefore looked forward to with considerable interest. The Li-ki was built in 1874. Her length is 191 feet; breadth, 22 feet; draught forward, 11 feet; and aft, 13 feet. She has two decks, the upper one carrying five guns. The state cabin, ward room, &c., are handsomely fitted, and the whole arrangements of the vessel are said to be very complete. Her officers are nearly all native Japanese.

A Curious Phenomenon. — During the storm of Sunday I noticed three flashes of lightning, one after the other, and at the end of the flash a bright green-looking ball, which seemed to remain behind for some time, and then burst with a rattling noise, and the noise in the phonoscope was very peculiar. I trust some reader will explain his.—J. Kempton, in *Design and Work*.

Photographic Copies of Mechanical Drawings.—An interesting process for the photographic reproduction of mechanical drawings, maps, &c., has recently been brought before the French Sociéte d'Encouragement by M. Pellet. The resulting copy is in blue lines on white paper, and the process is based on the property of perchloride of iron of being reduced to protochloride by light. The latter salt is not changed by a solution of prussiate of potash, while the former is immediately coloured blue. The copying paper is immediately sensitised by immersion in a bath formed of 100 parts of water, 10 of perchloride of iron, and 5 of oxalic acid (or other vegetable acid). The drawing, on transparent paper, is placed on a dry sheet of the copying paper, which is called "cyanofer," and exposed to the light under glass (15 to 30 seconds to the sun in summer, and 40 to 70 seconds in winter; in shade the exposure varies from 2 to 40 minutes, according to weather). The electric light may be used. After exposure the sheet is placed in a bath of prussiate of potash (15 to 18 per cent. of water), which immediately colours blue all the parts where the perchloride has remained intact, but does not affect the parts where the salt has been reduced by the light. Then the drawing is washed with water, and passed into a bath of 8 to 10 per cent. of hydrochloric acid, which removes the salt of protoxide of iron; then it is washed again and dried. The drawing now appears in deep blue tints on a very white ground.

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